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Room and Pillar Retreat Mining

A Manual for the Coal Industry

By Peter W. Kauffman, Steven A. Hawkins,
and Robert R. Thompson

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR
James G. Watt, Secretary
BUREAU OF MINES

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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PREFACE

This guidebook was prepared by Management Engineers Incorporated (MEI), Reston, Va., under Bureau of Mines contract H0282021. The contract was administered under the technical direction of the Spokane Research Center. Mr. Robert Thompson was the Technical Project Officer; Mr. David Askins was the Contract Administrator. Mr. Peter Kauffman acted as Project Director. Mr. Steven Hawkins was Project Manager.

This guidebook is the primary product from work completed under this contract during the period from September 14, 1978, to March 15, 1980. A final report detailing the conduct of the project was published under separate cover. The authors thank the many contributors to this project, including MSHA district and subdistrict managers and roof control specialists, equipment manufacturers, and mining companies. Particularly the authors thank the participating mining companies who gave generously of their time in discussions and in underground visits.

The authors also thank their consultants, Mr. Adler Spotte, Mr. Dewitt Foust, Mr. James Biller, Mr. Francis Martino, and Mr. John Pio, whose careful reading and critique added immeasurably to the final product.

Contributing to this project from MEI were Mr. Daniel Walton, Mr. William Ingham, Mr. Svend Rondum, Mr. George Little, and Ms. Patricia Webb. Clerical support was provided by Ms. Cathy Mack, Ms. Sandra Hoybach, and Ms. Patricia Naughton.

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ROOM AND PILLAR RETREAT MINING

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by

Peter W. Kauffman[1], Steven A. Hawkins[2], and Robert R. Thompson[3]

ABSTRACT

This Bureau of Mines publication is designed primarily to provide mine engineers and production-level mine managers with the following:

1. Information to assist them in making the decision to retreat mine and in selecting the best retreat mining technique for specific mining conditions.

2. Information on mine planning that will enable them to design mine layouts for safe and efficient retreat mining.

3. Information that will enable them to develop a section foreman's handbook.

The manual has been organized to gradually increase in level of detail as the reader progresses from beginning to end. Individuals interested in an overview of retreat mining can confine themselves to the first few chapters. Those interested in mine planning should read the middle chapters as well. Those interested in the development of a foreman's handbook should read the entire manual.

Chapter 1. INTRODUCTION

Room-and-pillar retreat mining, because of its complexities, can be effectively practiced only if mine management carefully develops a plan for mining and communicates this plan to the section foreman. This publication is designed to provide information to mine managers that will enable them to analyze all options and select and develop a mining plan that meets their particular needs. However, once the appropriate plan has been selected, the information must be effectively communicated to the section foreman. The most effective manner of accomplishing this is a simplified handbook that details the routine operations so that the foreman knows exactly the roof support, ventilation, and haulage requirements for any given cut.

The need to plan mine operations at this level and to communicate these detailed plans to mine foremen can be seen by looking at the mining industry

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3/ Research Structural Engineer, Spokane Research Center, Bureau of Mines, Spokane, Wash.

today. Those mining companies with a reputation for efficient and safe operations are planning at this level, and those with poorer operations generally are not. This manual will be of assistance to those mining companies interested in developing such a communication process, but each mining company must commit the resources to develop the handbook and follow up on its implementation and refinement.

The use of this manual depends to some extent on the user's needs and intentions. Mine managers--the primary users--should first be familiar with the range of retreat mining practices contained in chapter 2, Summary and Comparison of Mining Techniques. After reading this chapter, they will have an overview of the terminology and techniques that will be used throughout the remainder of the manual. Second, they should review chapter 3 and the appendix to find those techniques used by other mines in their area or under similar conditions. Third, they should study the detailed descriptions of the techniques that they wish to use.

Mine planners should review not only the same material as mine managers but also the information provided in chapters 6 and 7 to ensure that the physical conditions in which their operations are conducted are suitable for efficient retreat mining and that they comply with the regulations. Those individuals responsible for developing a foreman's handbook should review all chapters, particularly the information provided in chapters 8 and 9. Other users of this manual may be most interested in information provided in one particular chapter. Care should be taken to ensure that material is not taken out of context.

Chapter 2. SUMMARY AND COMPARISON OF MINING TECHNIQUES

Room-and-pillar retreat mining techniques vary widely over the United States. The techniques used in a particular area are dependent upon specific local conditions, the influence of experiences of adjacent mines, and the experience of local Mine Safety and Health Administration (MSHA) roof control specialists. This chapter contains a summary of each process for the extraction of individual pillars and each method of mining production panels. The material is presented without discussion of the relative success of each technique. Chapter 3 contains a discussion of the areas in the country employing each technique, and chapters 4 and 5 describe the most successful techniques with respect to safety and productivity.

Pillar Extraction Processes

In the course of selecting a pillar extraction process, the mine engineer should restrict himself, with few exceptions, to the widely used processes described in detail in chapter 4. The exceptions are the less common processes presented in the latter part of this chapter; these can be practiced successfully only in particular conditions and should not be attempted unless these conditions prevail.

Common Pillar Extraction Processes

Pillar extraction processes widely practiced in the industry include split and fender, pocket and wing, outside lifts, and open ending. The following discussions are intended to provide a brief summary of applicable processes; accordingly, much of the detail commonly found in roof control

plans is omitted. For the more widely used techinques, all necessary detail is included in chapter 4.

Split and Fender

Split and fender is the most commonly used pillar extraction process in the United States. It is best used where a relatively small pillar is to be extracted; however, a large pillar can be extracted using multiple splits. The basic concept of the process is to mine in a sequence of cuts through the pillar, generally parallel to the pillar's long side. This mining forms a split through the pillar and creates two fenders of coal. The roof within the split may be supported by bolts, posts and timbers, or a combination as required. Fenders are extracted from the split or adjacent entry with additional support provided by posts. Generally, multiple pillars are extracted simultaneously in order to provide an adequate number of working places to avoid delays. A typical sequence of cuts is shown in figure 1. The numbered areas in the two pillars represent the cut sequence. The sequence shown is for continuous mining equipment. Variations are required for continuous haulage or conventional mining equipment.

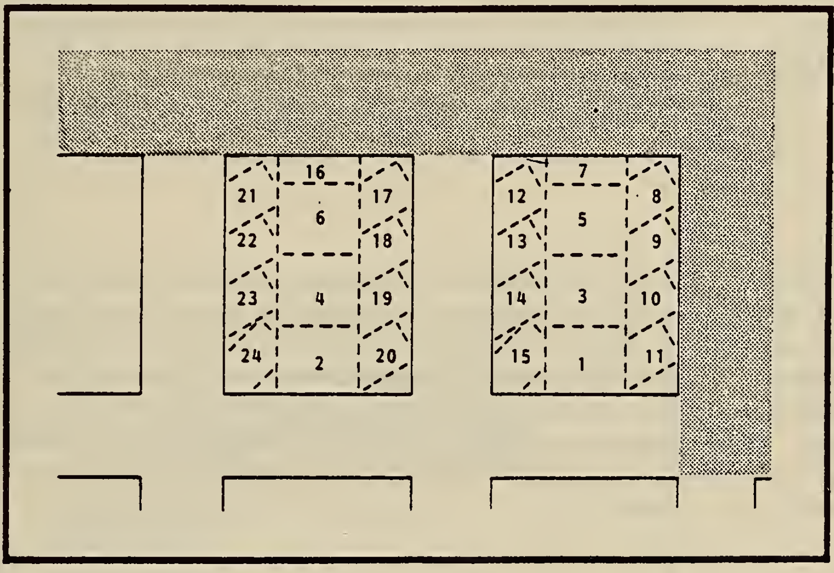


FIGURE 1. - Split-and-fender cutting sequence.

Pocket and Wing

Pocket and wing is a process used primarily for the extraction of large pillars. It is practiced under widely varying conditions throughout the country, but only a few mining companies are using it. The pocket-and-wing process allows two working places within the same pillar. Pockets are driven on the gob sides of the pillar, and lifts are usually sequenced between pockets to provide a place for both mining and roof bolting. A wing or fender of coal is left between the pocket and the gob. When the pocket is completed, the wing is recovered. Additional pockets are driven and wings extracted until the pillar is reduced to a final stump or pushout. This

stump is recovered from the intersection. Additional cuts are sometimes required in adjacent pillars to eliminate production delays. A typical sequence of cuts is shown in figure 2.

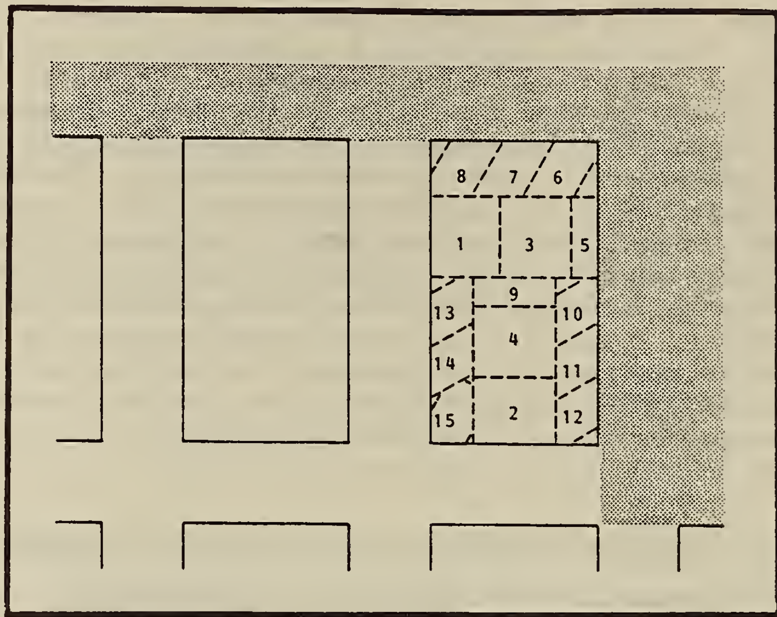


FIGURE 2. - Pocket-and-wing cutting sequence.

Outside Lifts

The outside-lift pillar extraction process has been used by a few mines with very good success. This process is suitable only for small pillars. The variations are many, depending upon conditions, pillar dimensions, and equipment. Generally, the pillar is dimensioned so that lifts taken from one side of the pillar are sufficient to extract the pillar without going beyond supported roof. The sequence of cuts involves taking lifts from the pillar beginning near the gob and moving toward solid coal. The sequence of cuts shown in figure 3 is typical.

Open Ending

This process for pillar extraction is used widely by mines using conventional mining equipment. The process consists of taking lifts in a sequence of cuts generally on one side of a pillar. Cuts are taken from as many as six pillars simultaneously, each at a different stage of the five conventional operations of cut, drill, shoot, load, and bolt. The pillar line is generally at a 45-degree angle. The sequence of cuts shown in figure 4 is for one pillar only; however, similar cuts are made simultaneously in the other pillars in the line.

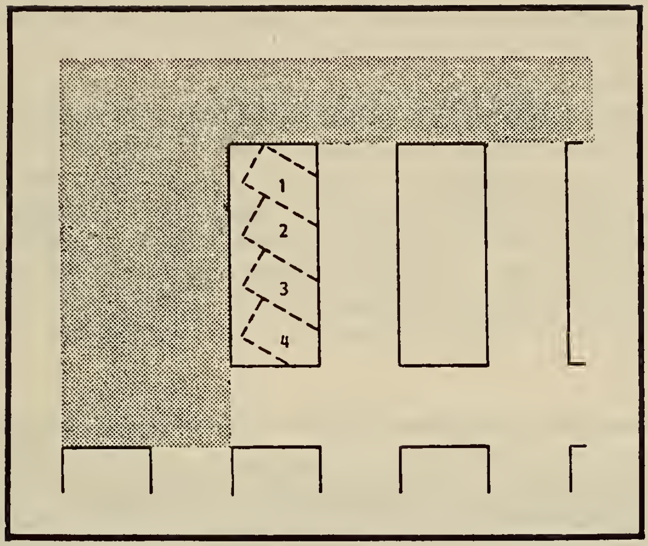


FIGURE 3. - Outside-lift cutting sequence.

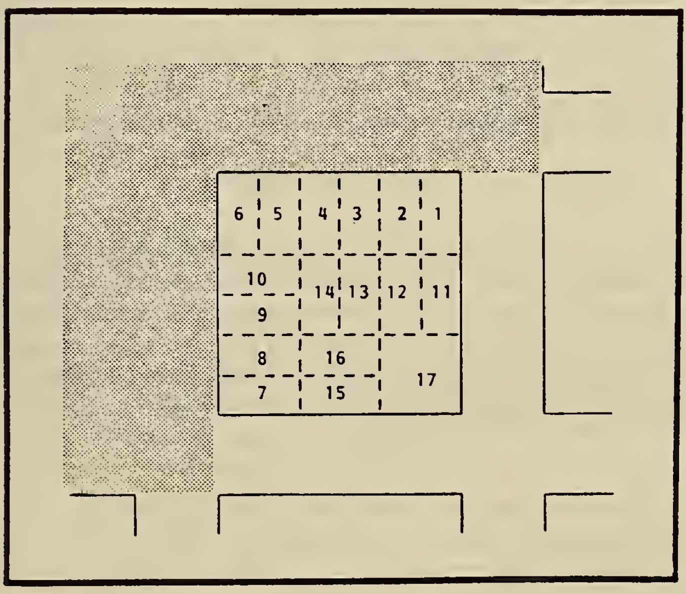


FIGURE 4. - Open-ending cutting sequence.

Split-and-Fender Modifications

Because split and fender is the most commonly practiced pillar extraction process in the United States, it is also the most widely modified. Six of the variations are sufficiently adaptable to make them worthy of mention in this chapter.

Multiple Splits. The single split process shown in figure 1 is suitable for the mining of many of the smaller pillars used in the United States. If pillar width exceeds 45 feet, however, it is no longer possible to extract the fenders remaining after a single split is taken through the pillar. To accomplish the extraction of these larger pillars, many mines take two or three splits through the pillars. A typical cut sequence for removal of pillars using two splits is shown in figure 5.

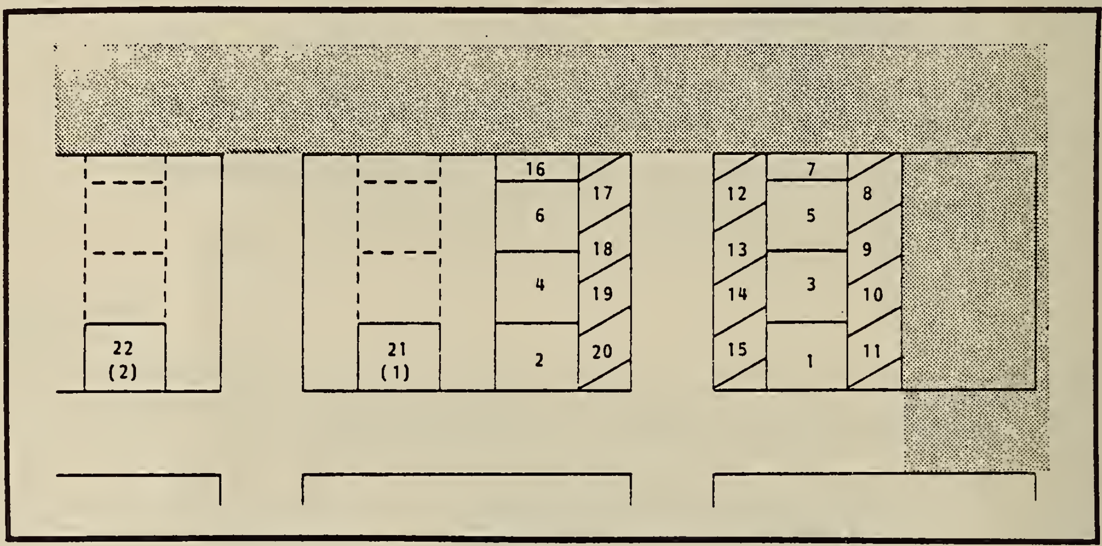


FIGURE 5. - Multiple splits.

The pillars shown are approximately 65 feet wide. Notice that cuts in the second split in the inby pillar are sequenced with the first split in the outby pillar: that is, cuts 21 and 22 are identical to cuts 1 and 2, respectively. Similar plans can be developed for three splits. It should be pointed out that when extracting large pillars, the use of the pocket-and-wing extraction process may be preferable to the use of a multiple-split-and-fender process.

Christmas Treeing. This practice involves taking two fenders from the same split or entry. Two sequences are prevalent. The first involves the extraction of a single pillar. As shown in figure 6, cuts are made to the left and then to the right (8 before 9, 10 before 11, etc.).

The second method, shown in figure 7, involves the extraction of two pillars from the same entry. In this sequence, extraction of the final stump is difficult; often this stump must be sacrificed.

In both Christmas treeing methods, the continuous miner is beneath the middle of a relatively large unsupported span rather than near a rib protected by solid coal. Exposure is greatly increased. These methods are most often used when access to the pillar through an entry or crosscut has been blocked or when leaving a partial pillar would create a dangerous hanging fall. Use of either of these methods is not encouraged under normal circumstances.

Indicator Stump. Another variation of the split-and-fender process is the indicator stump. The final cuts in the split are angled outward in a manner that leaves a wedge-shaped stump in the center of the end of the split, as shown in figure 8. The crew observes the rate of disintegration of the stump as an indicator of roof activity while the inby fender is being extracted.

Fender Breakthrough. One variation that can be used with either of the pillaring processes involving fenders (split-and-fender and pocket-and-wing) is the fender-breakthrough technique. This technique is generally used in locations where narrow fenders (approximately 8 feet) are used and involves periodically breaking through the inby fender into the gob as the split is being advanced. These breaks serve as indicators of the fender thickness to aid the miner operator and also aid in ventilation. A typical cut sequence showing these breaks in shown in figure 9. After the split is completed, the fender is extracted in the normal fashion.

Fender Notching. This technique involves cutting a notch to the left of the split as the fender to the right is extracted. This practice can be used to increase recovery with minimal exposure to hazardous conditions. A typical cut sequence (fig. 10) involves the removal of small wedge-shaped cuts of coal from the outby fender as the inby fender is being removed. Ideally, the positioning of these notch cuts coincides with the lifts that will be removed from the outby fender when that fender is recovered from the entry or split. Since these cuts are taken from under supported area, no hazardous exposure is created.

Conventional Split and Fender. The split-and-fender process is also used with conventional mining equipment. The use of conventional mining equipment may be desirable when mining a hard coal or coal layered with rock. However, these conditions require large charges to break the coal. With open ending, such a charge might result in a high percentage of the coal being blown into the mined out area. The use of the split-and-fender technique confines the coal between the fenders and increases the recovery rate. A typical extraction sequence is shown in figure 11.

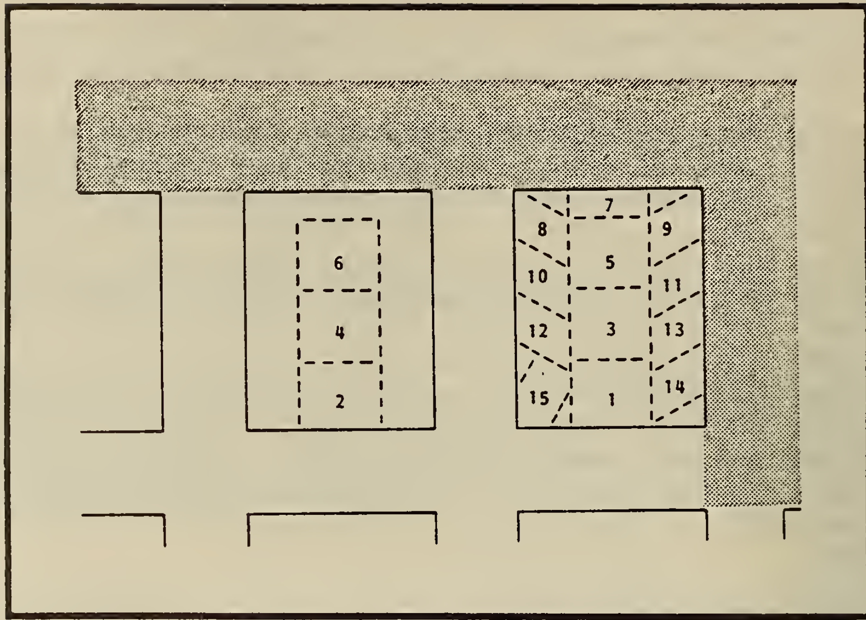


FIGURE 6. - Christmas-treeing cutting sequence (one pillar).

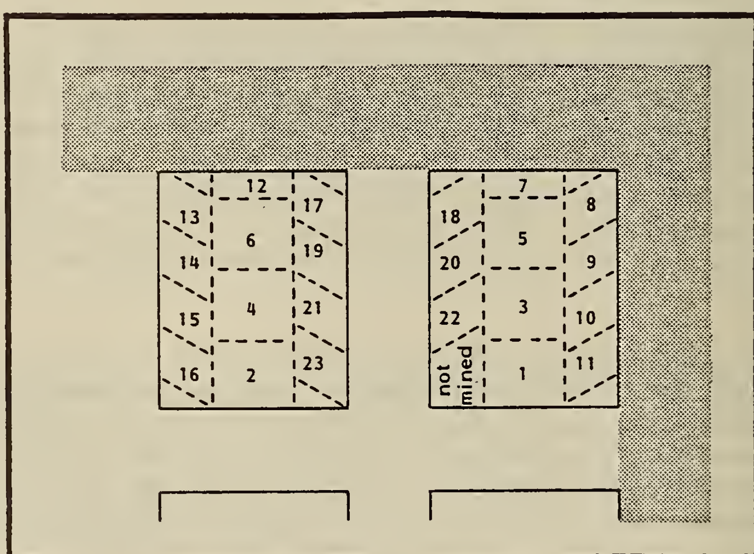


FIGURE 7. - Christmas-treeing cutting sequence (two pillars).

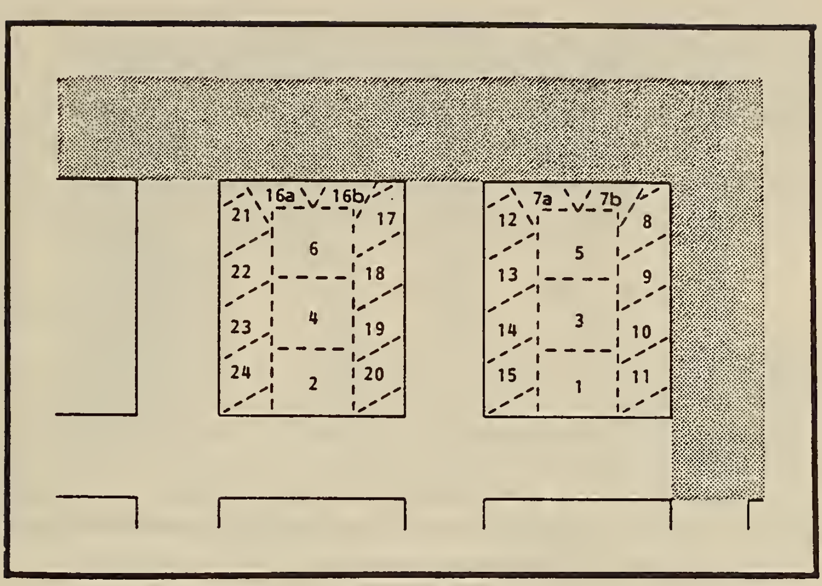


FIGURE 8. - Indicator-stump cutting sequence.

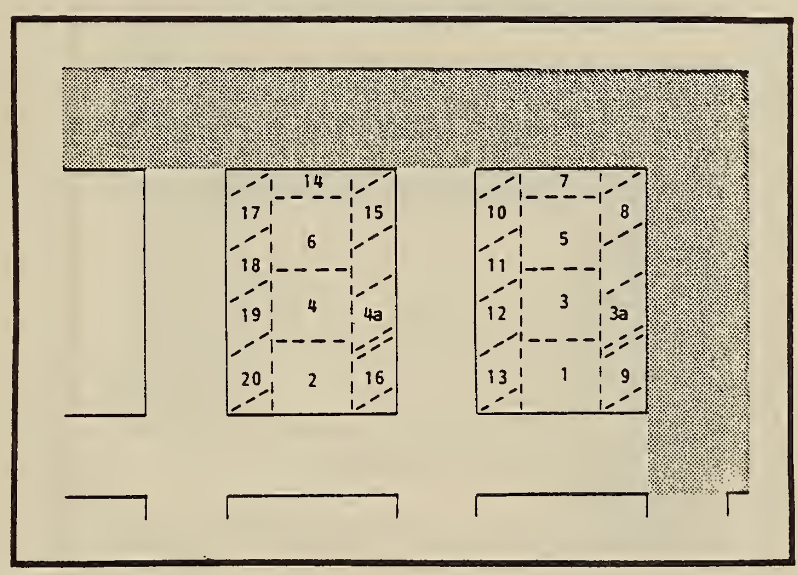


FIGURE 9. - Fender-breakthrough cutting sequence.

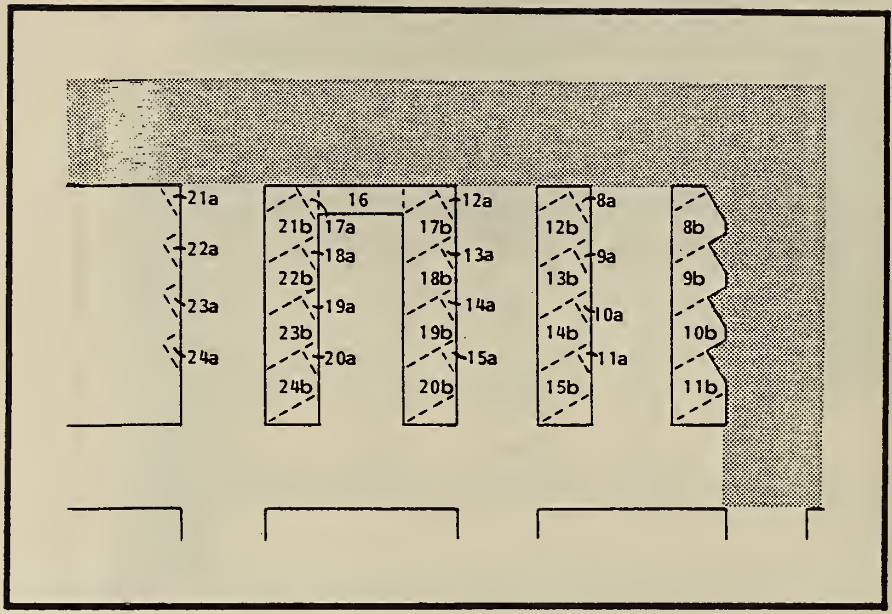


FIGURE 10. - Fender-notching cutting sequence.

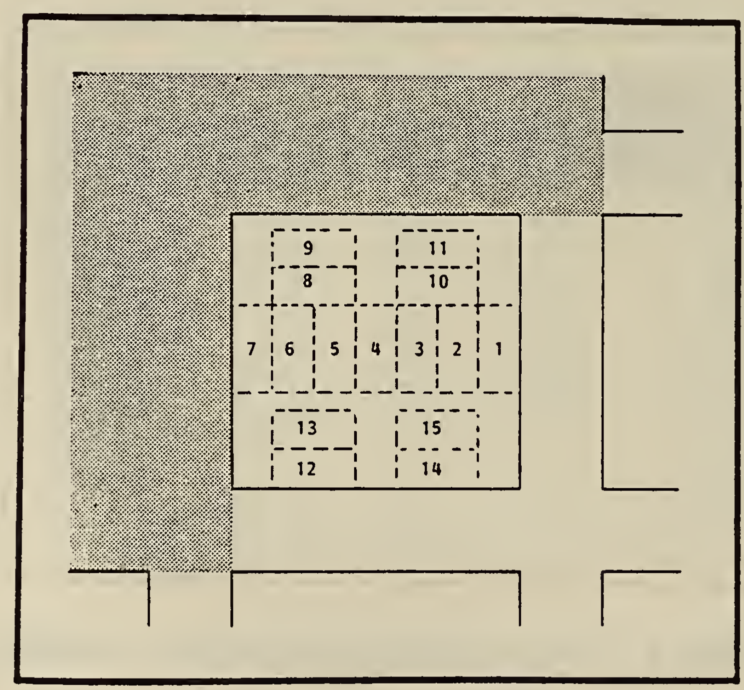


FIGURE 11. - Split-and-fender cutting sequence using conventional mining equipment.

Pocket-and-Wing Variations

Three of the variations to split-and-fender pillar extraction can also be used in the extraction of pillars by the pocket-and-wing process--indicator stump, fender breakthrough, and fender notching. One other pocket-and-wing variation used quite commonly is nonsequential pocket and wing. This variation is made possible by the use of miners with on-board bolters or the use of boring-type continuous miners. In areas of high gas and frail top, the nonsequential pocket-and-wing technique can prove very beneficial, since air can be directed to a single face throughout the extraction process. A typical cut sequence for this variation is shown in figure 12. It should be noted that with the pocket-and-wing method, any number of pockets can be driven, as required by the physical dimensions of the pillar block and as restricted by law.

Outside-Lift Variations

The basic outside-lift cut sequence that was shown in figure 3 is very limited in its application. Because of the practical limitations on miner reach, the technique cannot be used with pillars significantly wider than 20 feet. This process is generally applicable for the removal of room pillars, with the use of other techniques to remove the chain pillars.

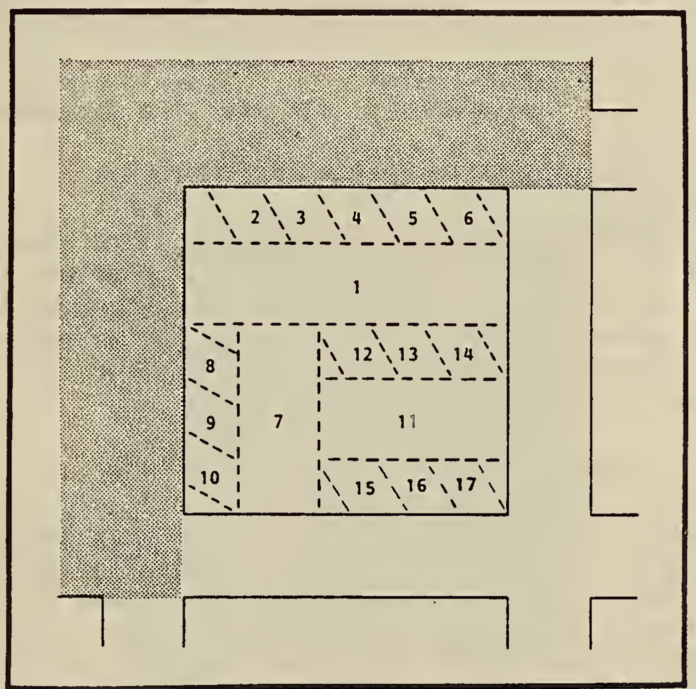


FIGURE 12. - Nonsequential-pocket-and-wing cutting sequence.

A variation of the outside-lift process that closely resembles the practice of split-and-fender Christmas treeing is a combination of outside lifts and Christmas treeing. Using this process, it is possible to extract

pillars up to 30 to 35 feet wide, but even these pillar dimensions limit the use of the process to areas of low overburden pressures and easily breakable top. This process results in significantly greater amounts of extracted coal without bolting (free coal) than any other pillar extraction process presented. However, the increase in free coal must be carefully weighed against the hazards involved with use of this modification. A typical sequence of cuts for outside-lift Christmas treeing is shown in figure 13.

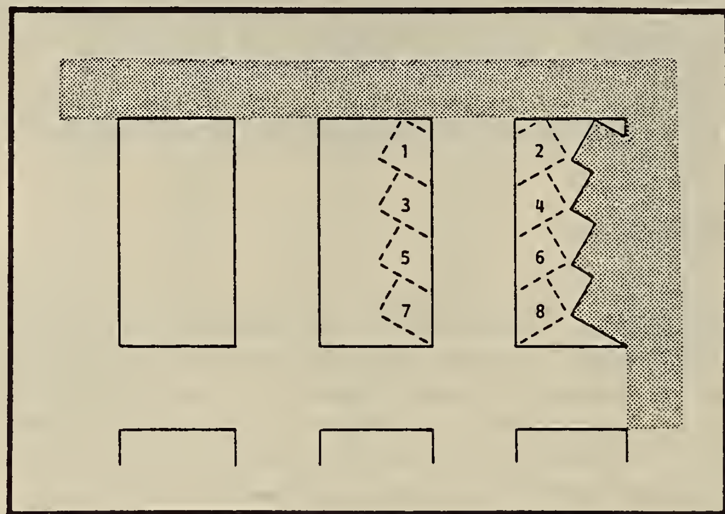


FIGURE 13. - Cutting sequence for outside-lift Christmas treeing.

Other Pillar Extraction Processes

Although the vast majority of pillar extraction processes in use in the United States fall into one of the four basic process classifications, there are a number of other extraction processes in use. Because these processes are not acceptable under all conditions, are subject to many equipment limitations, and are not recommended for mines not experienced in pillar extraction, they are not included in this report.

Methods of Mining Production Panels

The primary methods of mining production panels are described in this section. The group of entries driven into the panel is referred to as a panel entry set. Each panel entry set may include three to eight or more entries. The pillars formed by the panel entry set are referred to as chain pillars. Any rooms driven off the panel entry set are referred to as production rooms, and the resultant pillars are called production pillars.

The basic methods used by the industry include the following:

1. Full panel extracted on retreat. The full panel is developed with no differentiation between the panel entry set and production rooms. The entire panel is extracted on retreat.

2. Rooms driven and extracted on retreat. The panel entry set is developed with production rooms driven and pillars extracted on retreat.

3. Rooms driven and extracted on both advance and retreat. The panel entry set is developed with production rooms driven and production pillars extracted on one side while advancing the panel and on the other side while retreating the panel.

4. Rooms only. The panel entry set is developed with rooms driven while advancing and retreating the panel with no recovery of pillars.

In all designs, a panel entry set forming the neck is started off the submains for a distance sufficient to provide an adequate barrier pillar. The panel is then normally widened. The width of the panel usually ranges from 300 to 600 feet and is dictated by haulage constraints or other factors. The length of the panel is usually 2,000 to 4,000 feet depending on the length of panel belt, the use of rail, or other factors.

Full Panel Extracted on Retreat

In this design, a full width panel consisting of as many as 10 to 12 entries is developed off the neck. The panel is developed to the designated length. After development, a bleeder system is established and pillar extraction is begun. A pillar line is established either at an angle, common to both continuous and conventional mining, or flat (90°), common to continuous mining. Pillars are extracted until the entire panel has been mined. Figure 14 shows a typical configuration for full panel extracted on retreat.

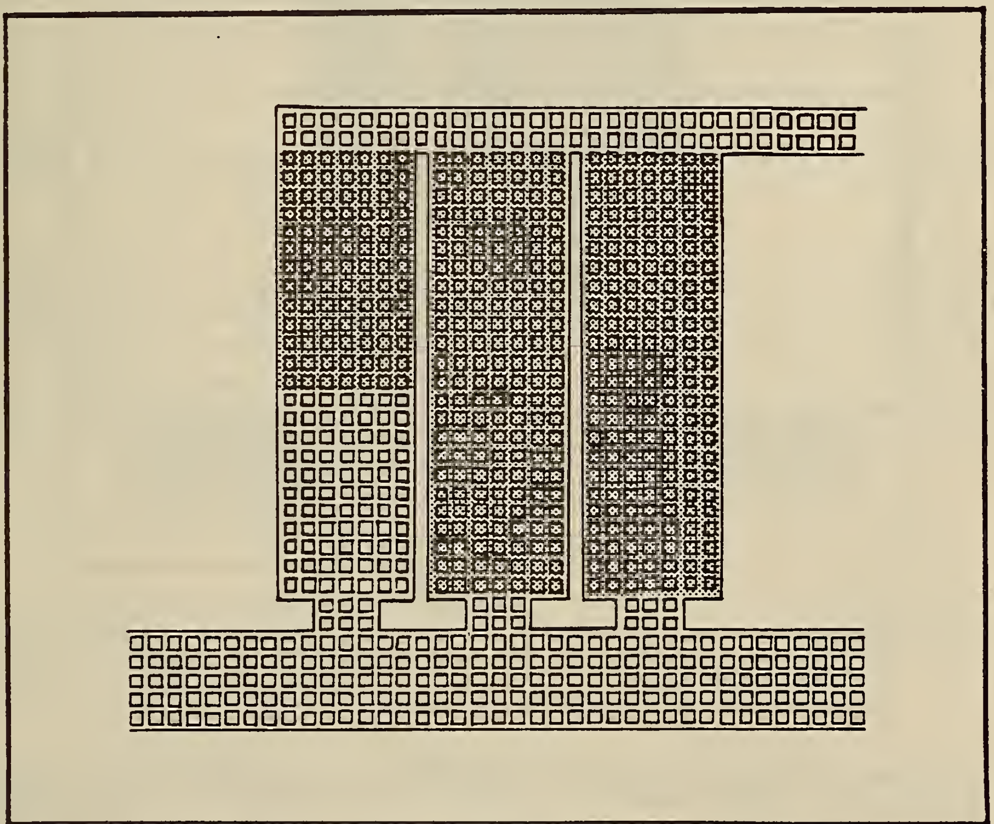


FIGURE 14. - Full panel extracted on retreat.

Rooms Driven and Extracted on Retreat

In this design, a panel entry set usually only large enough to handle the necessary ventilation, haulage, and other supporting functions (generally three to five entries) is completely developed to the designated panel length, and the panel entry set is connected to the bleeder system. During retreat from the panel, rooms are driven and pillars extracted on the way out of the rooms. The rooms may be developed and extracted on only one side or in groups alternately on both sides of the entry set. Pillar lines can be flat or angled. This method is not practiced using conventional mining equipment because of limitations on the number of working places. Figure 15 shows a system where rooms are driven off only one side of the panel and the production and chain pillars are extracted.

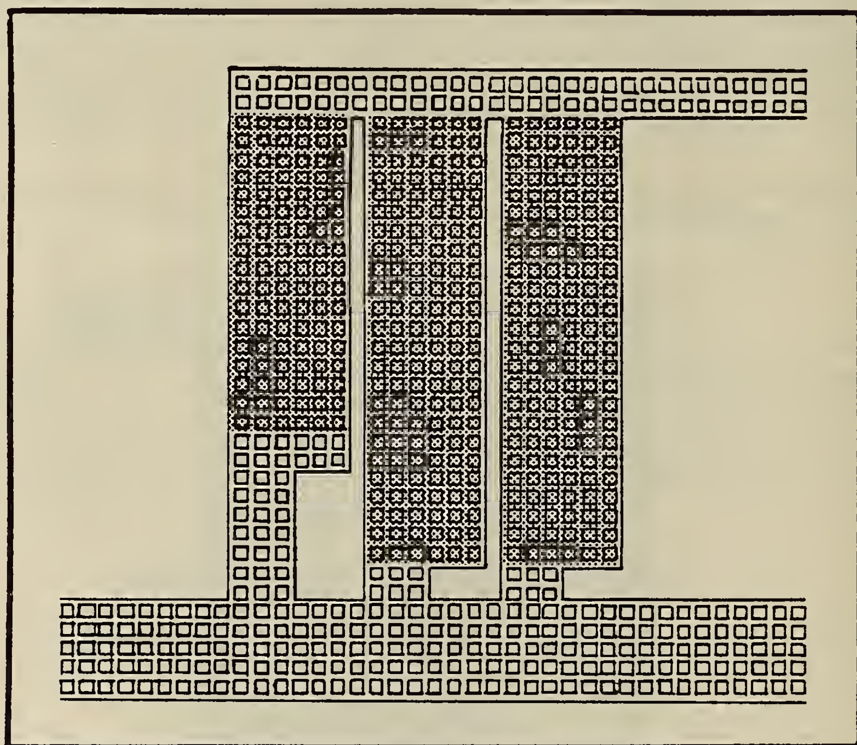


FIGURE 15. - Rooms driven and extracted on retreat.

Rooms Driven and Extracted on Advance and on Retreat

In this design, as the panel is developed, rooms are driven, and production pillars are extracted on one side of the panel entry set. When the panel entry set is completed, a bleeder is established. Rooms are then driven and the pillars extracted on the other side of the panel entry set as the panel entry set is retreated. The pillar line can be flat or angled.

Due to limitations on the number of working places, this method is not practiced with conventional mining equipment. Figure 16 shows this configuration.

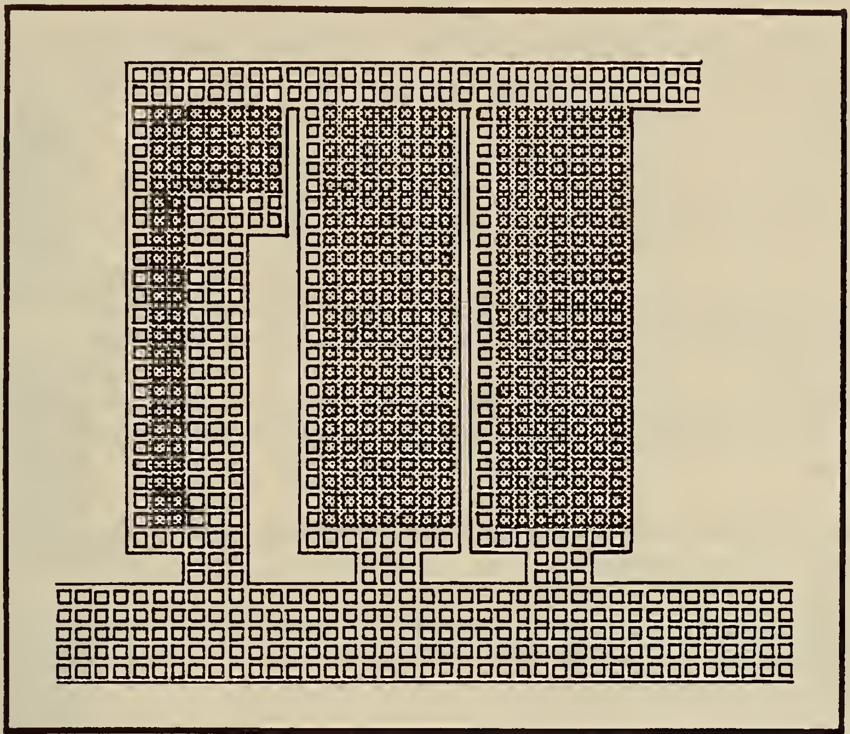


FIGURE 16. - Rooms driven and extracted on advance and on retreat.

Rooms Only

In this method, a panel entry set only large enough to handle the necessary ventilation, haulage, and other supporting functions is developed to the designated panel length. The entry set is connected to the bleeder system. Production rooms in sets of four or five are driven in both directions as the equipment is retreated from the panel. No second mining is conducted. This system can be employed with any equipment. Figure 17 shows a typical configuration.

Evaluation of Methods

Each of the four retreat mining methods presented have certain advantages and disadvantages. Each is used successfully in one area or another of the United States. Table 1 lists the specific advantages and disadvantages of each method, keyed to the following desirable features.

1. Active places should not be maintained near a caved area. The increased pressures in the vicinity of a caved area make these areas less desirable for active workings.

2. The length of time that openings are maintained should be minimal. Reducing the amount of time that the roof is exposed to air and moisture will decrease the rate of deterioration.

3. Solid coal should be retained on one side of the panel entry set to reduce pressures on the chain pillars.

4. Workplaces should be concentrated in a limited area. This decreases the area of control for the section foreman and allows for more effective management of the operations.

5. Tonnage produced between major logistic changes such as belt moves, track moves, or power center moves should be as high as possible. This reduces the percentage of nonproductive time.

6. Average haul distances should be minimized to increase efficiency and help reduce nonproductive time caused by haulage delays.

7. The ventilation system should operate with a minimum number of changes from one cut to another. This reduces nonproductive time and required supervision.

8. The bleeder system should be easy to establish and maintain to help reduce ventilation problems.

9. The maximum amount of reserves should be recovered. Coal left in the panel is lost and decreases the economics of the operation, assuming a cost-effective recovery rate.

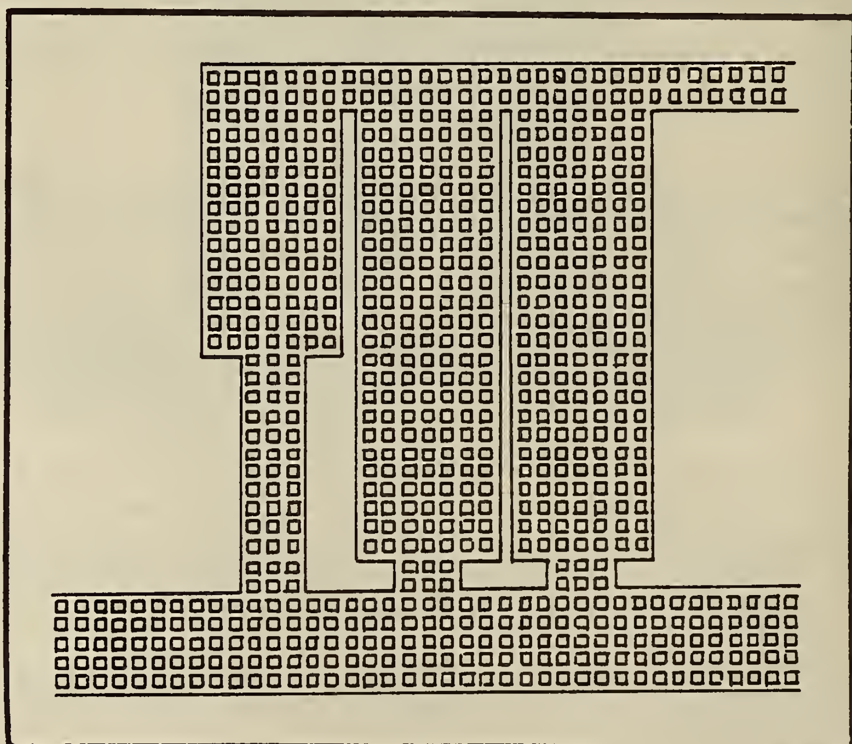
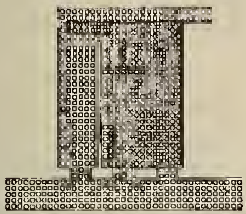
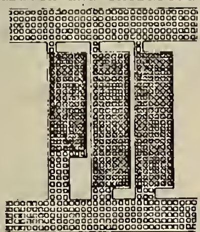
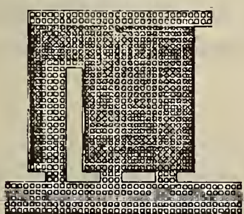
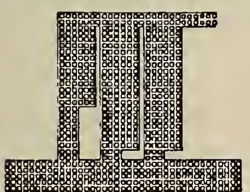


FIGURE 17. - Rooms only.

TABLE 1. - Advantages and disadvantages of panel mining methods.

Retreat Mining Method	Advantages	Disadvantages
1. Full panel extracted on retreat 	1. No active place need be maintained near a caved area. 3. Solid coal on one side of the panel. 5. Highest tons extracted per belt move. 6. Short average haulage distance. 7. Easily ventilated. 8. Easily bled. 9. Maximum recovery of reserves.	2. Roof must be maintained for a long period over the life of the panel. 4. Work places are not concentrated.
2. Room driven and extracted on retreat 	1. No active place need be maintained near a caved area. 2. Short time to maintain roof. 3. Solid coal on one side of the panel. 4. Work places are concentrated. 7. Easy to ventilate. 8. Easily bled. 9. Maximum recovery of reserves.	5. Low tons extracted per belt move. 6. Fairly long average haul distance.
3. Room driven and extracted on advance and on retreat 	2. Short time to maintain roof. 4. Work places are concentrated. 9. Maximum recovery of reserves.	1. Active place must be maintained near a caved area. 3. Solid coal not on one side of panel entry set. 5. Low tonnage extracted per belt move. 6. Fairly long average haul distance. 7. Difficult to ventilate. 8. Difficult to bleed.
4. Room only 	1. No active place need be maintained near caved area. 2. Short time to maintain roof. 3. Solid coal on one side of the panel. 4. Work places are concentrated. 7. Easy to ventilate. 8. Easily bled.	5. Low tonnage extracted per belt move. 6. Fairly long average haul distance. 9. Poor recovery of reserves.

Chapter 3. REGIONAL RETREAT MINING PRACTICES

This chapter contains a discussion of the retreat mining practices in each geographic region in the country. The geographic regions are divided according to the MSHA Districts. The mining practices and, specifically, the processes utilized to extract pillars are presented. There are 10 MSHA Health and Safety Districts in the United States (fig. 18). The retreat mining practices in all but one of the districts are discussed in the material that follows. MSHA District 1 is not discussed since this district contains only anthracite coal mines. A more detailed breakdown of retreat mining practices by seam is contained in the appendix.

MSHA District 2

District 2 encompasses the bituminous coal fields of western Pennsylvania. Coal is found primarily in six seams: Upper Freeport, Pittsburgh, Lower Kittanning, Lower Freeport, Upper Kittanning, and Sewickley. Mining also takes place in the Clarion, Middle Kittanning, and Brookville seams.

Some of the important features and techniques in District 2 are as follows:

1. The split-and-fender process dominates the mines in the eastern portion of the district (the Freeport and Kittanning seams). Success is being achieved with the outside-lift process in some of the mines in the Freeport seams. The seams in this area of the district tend to be in more heavily folded strata and under lower overburden pressures than seams at the western end of the district.

2. In the Pittsburgh seam in the western end of the district, the pocket-and-wing process is most common. The Pittsburgh seam is the most important seam in the district volumetrically and is one of the major producing seams in the United States. This area, and its corresponding area in District 3, are the main users of the pocket-and-wing process in the United States.

3. Overall, 85 out of 122 (70 percent) of the mines in the district have some form of a pillar extraction plan on file.

FIGURE 18. - Coal mine health and safety districts.

MSHA District 3

District 3 comprises the northern portion of West Virginia (including the panhandle) and the western counties of Maryland. It shares many mining characteristics with the western portion of District 2, which lies immediately to the north. Mining takes place in a total of 12 seams in the district. Significant mining takes place in seven of these seams: Pittsburgh, Upper Freeport, Sewell, Redstone, Sewickley, Middle Kittanning, and Peerless.

Some of the notable features of District 3 are as follows:

1. In the Pittsburgh seam, pillar extraction is difficult in the areas of the district near the Ohio River (Marshall and Brook Counties) because of a massive limestone main roof. In Monongalia and Marion Counties, the conditions are similar to the western portion of District 2, and the pocket-and-wing pillar extraction technique prevails.

2. Full pillar extraction is not common in the Upper Freeport seam in the district. A limited number of mines are having success with full pillar extraction of the Upper Freeport seam in Grant County using the outside-lift process.

3. Full pillar extraction is practiced successfully in the Redstone seam using the split-and-fender process.

4. Districtwide, 79 of 132 (60 percent) of the roof control plans include pillar extraction plans.

MSHA District 4

District 4 is the largest district (in terms of number of mines) under the control of MSHA. District 4 comprises the southern counties of West Virginia. Mining takes place in 35 seams in District 4, 29 of which contain 5 or more mines. Some of the notable features of District 4 pillar extraction processes are as follows:

1. Of the most active 15 seams in the district, only the Pocahontas seam has a majority of mines practicing pillar extraction.

2. All seams have a significant number of mines practicing pillar extraction successfully. This implies that, in general, there is no geologic limitation to discourage mining companies in this area from practicing pillar extraction of some form.

3. In total, only 371 of 1,069 roof control plans (35 percent) showed some form of pillar extraction.

MSHA District 5

District 5 comprises the Commonwealth of Virginia. Mining takes place in 18 seams in 5 western counties in Virginia. Fifteen of these seams contain five or more coal mines. Some notable features of District 5 pillar extraction practices are as follows:

1. Roof control plans for the majority of mines in any seam in the district do not indicate pillar extraction.

2. Only 198 of 965 roof control plans (21 percent) show some form of pillar extraction. A significant number of mines do practice pillar extraction, however, in most seams in Buchanan County.

MSHA District 6

District 6 comprises the northeastern section of Kentucky. Mining is conducted in 16 seams, 13 of which contain 5 or more mines. Some of the notable features of District 6 pillar extraction practices are as follows:

1. Roof control plans for the majority of mines in any seam do not indicate the use of any secondary pillar extraction techniques.

2. Only 181 of 888 roof control plans (20 percent) show some pillar extraction. The vast majority of these are partial extraction. Full pillar extraction is practiced almost solely in Pike and Letcher Counties.

MSHA District 7

District 7 encompasses large portions of the Southeastern United States. The significant coal mining areas are located in the States of Alabama, Tennessee and Kentucky. Each State's retreat mining practices will be briefly mentioned.

Alabama

Mining is conducted in six seams in Alabama. Three of these seams have five or more mines. Only 9 of 28 roof control plans show pillar extraction processes. Only in the Pratt seam is pillar extraction shown in the majority of roof control plans. Open-end pillar extraction is relatively common among those mines practicing pillar extraction in this area.

Kentucky

Mining is conducted in 16 seams in the central portion of Kentucky included in District 7. Nine of these seams contain five or more mines. Pillar extraction does not predominate in any seam in this district. Only 86 out of 586 roof control plans (15 percent) show the use of any pillar extraction processes. The number and location of mines practicing at least partial pillar extraction, however, indicate that pillar extraction in this district is possible in most seams.

Tennessee

Mining is conducted in 20 seams in the eastern portion of Tennessee. Ten of these seams contain five or more mines. Only 21 of 220 roof control plans (10 percent) show pillar extraction processes. Pillar extraction does not predominate in any seam in the district. There are partial pillar extraction plans on file for mines in the Dean and Sewanee seams, indicating that pillar extraction in these seams is possible.

MSHA District 8

District 8 comprises the majority of the Illinois Basin coalfield. Mining in District 8 takes place in Illinois, Indiana, and Ohio. Ohio's coal mining areas are in the Appalachian region and will be discussed separately from Illinois and Indiana.

Illinois and Indiana

Mining takes place in four seams in Illinois and Indiana. Fourteen of 31 roof control plans (45 percent) for the area contain some form of pillar extraction.

The major seam in the district is the Illinois No. 6 or Herrin seam. Extensive retreat mining takes place in the seam in Franklin and Jefferson Counties.

Ohio

The eastern portion of Ohio contains minable seams that are on the western edge of the Appalachian coalfield. No full pillar extraction takes place in this area due to massive limestone in the main roof and problems associated with pressure overrides. Fourteen of 29 roof control plans (48 percent) for the area do contain plans for partial pillaring. The greatest concentrations of pillaring are in the Pittsburgh Nos. 8 and 6A (Lower Freeport) seams. All mines in the Pittsburgh No. 8 seam and all but one in the No. 6A seam practice partial pillar extraction.

MSHA District 9

District 9 includes most of the coal mining States west of the Mississippi River. Iowa, Missouri, Arkansas, Louisiana, Kansas, Oklahoma, and Texas are included in District 10, since they have recently been transferred from this district. Underground coal mining takes place in four of the remaining States: New Mexico, Wyoming, Colorado, and Utah.

One underground mine is located in Wyoming. It does not practice pillar extraction. Both of the underground mines in New Mexico practice pillar extraction using the split-and-fender process.

In Colorado, underground mining takes place in 18 coal seams. Only two seams contain five or more mines. Fourteen of the 32 roof control plans for the State (44 percent) contain plans for some form of pillar extraction.

Underground coal mining in Utah takes place in 11 seams. Only the Hiawatha seam contains five or more mines. Nineteen of the 27 roof control plans for Utah (70 percent) contain pillar extraction plans. Split-and-fender extraction is shown in 17 of these plans.

MSHA District 10

District 10 is comprised of western Kentucky, western Tennessee, and--since the recent transfer of seven States from District 9 to District 10--Iowa, Missouri, Arkansas, Louisiana, Kansas, Oklahoma, and Texas. Arkansas, Iowa, and Oklahoma have a total of six underground mines, none of which practices pillar extraction.

There are 28 underground mines in western Kentucky. One mine is conducting partial pillaring using outside lifts on a trial basis. The mining operations are generally under little overburden in flat farming areas, and subsidence is felt to be undesirable because it would affect the water table upon which the farming depends.

Summary

Table 2 summarizes the retreat mining practices for each district. Further, the appendix includes charts that summarize the mining practices classified by MSHA district, State, seam, and county. Each table indicates county, number of roof control plans, the most popular process, the number of mines using each of the full extraction methods, the number of mines using partial extraction methods, and the number of mines that do not pillar.

TABLE 2. - Summary of mining practices

District	Area	Number of roof control plans reviewed	Number of with pillar extraction plans	Percentage of mines with extraction plans
2	Western Pennsylvania	122	85	70
3	Northern West Virginia and Maryland	132	79	60
4	Southern West Virginia	1,069	371	35
5	Virginia	965	198	21
6	Northeastern Kentucky	888	181	20
7	Alabama	28	9	32
	Central Kentucky	586	86	15
	Eastern Tennessee	220	21	10
8	Illinois and Indiana	31	14	45
	Ohio	29	14	48
9	Colorado	32	14	44
	Wyoming	1	0	0
	Utah	27	19	70
	New Mexico	2	2	100
10	Western Kentucky and western Tennessee	28	0	0
	Iowa, Mississippi, Alaska, Lousiana, Oklahoma, Kansas, and Texas	6	0	0
All	United States	4,166	1,093	26

Chapter 4. THE BASIC PILLAR EXTRACTION PROCESSES

Chapter 2 presented a summary description of common panel extraction methods and pillar extraction processes. The four basic pillar extraction processes are described in detail in this chapter. These processes--split and fender, pocket and wing, outside lift, and open ending--with their variations, account for nearly all production from full retreat mining and are adaptable for use under almost any set of background conditions in which it is possible to retreat mine. In the present chapter, information that will aid in choosing the best process to use is presented, including the characteristics, limitations, and geographical areas of successful usage.

The drawings in this chapter, which are reprinted from a contract report, reflect the appearance of the workplace immediately following the completion of mining. The positions of curtains and timbering are as they would appear at the completion of the cut. Where more than one cut is shown, the positions for timbers, ventilation, and haulage are for the first cut only.

Split and Fender

The split-and-fender process, also known as the split-and-wing or split-and-pillar process, is the most commonly used pillar extraction process in the United States. The characteristics of the process and the conditions under which it is frequently used are described below, as well as the areas of the country and seams in which the split-and-fender process is practiced.

Description of the Process

The basic concept of the split-and-fender process is to mine through an existing pillar generally parallel to the pillar's long side. This process forms a split through the pillar and creates two fenders of standing coal, one on either side of the split. The roof within the split is supported. The width of these fenders is, ideally, such that they can be wholly extracted within the mining equipment's reach without requiring additional roof support. This limitation usually dictates a maximum pillar width of 40 to 45 feet. If this is not the case, it may be necessary to extract the pillar by taking multiple splits or using a pillar extraction process better suited to large pillars (such as pocket and wing).

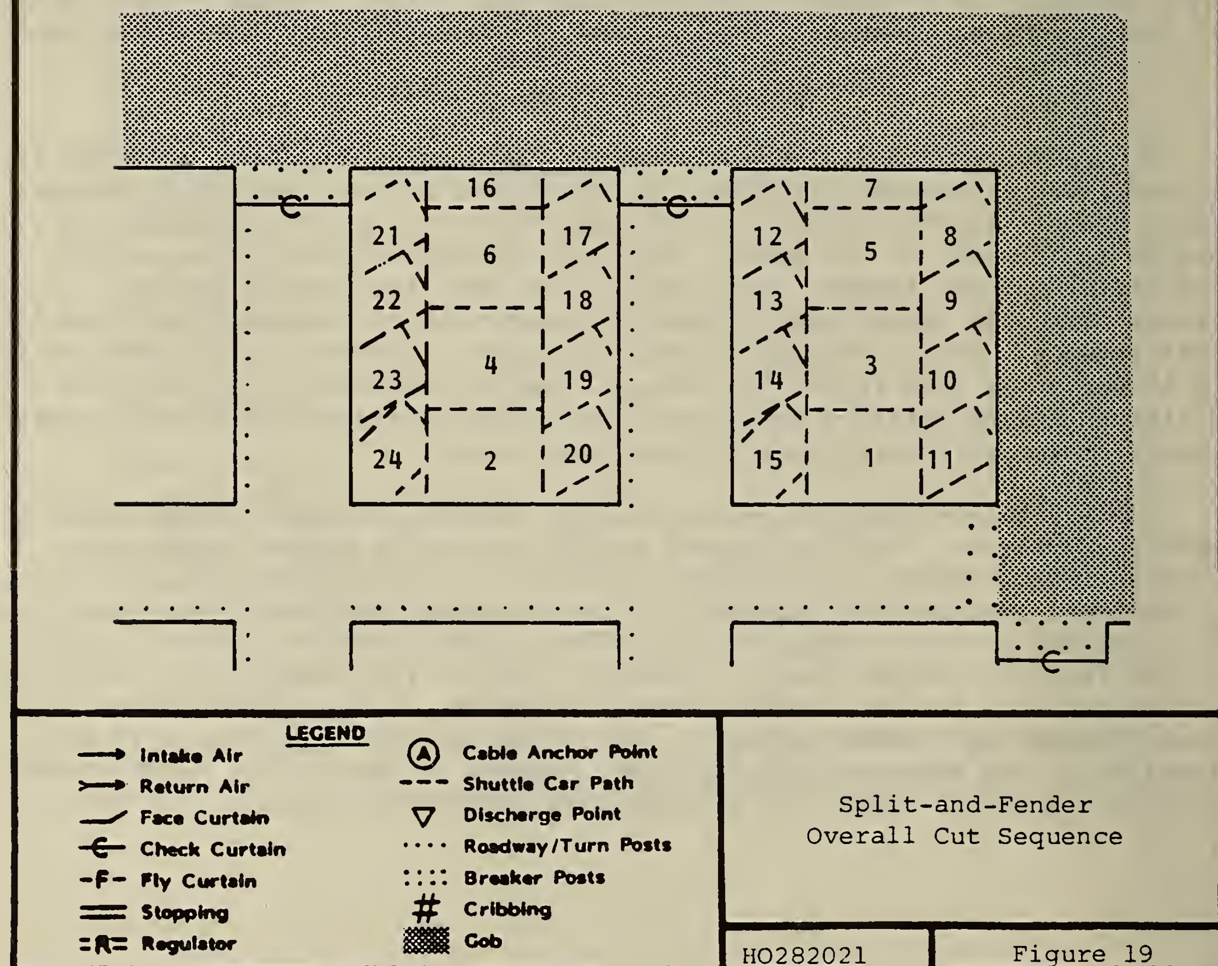
The split-and-fender process generally involves mining simultaneously at least two pillars. If roof support activities can be accomplished simultaneously with mining (using onboard bolting or some similar means), or if extensive delays for roof support can be tolerated, then split and fender can be practiced within a single pillar. When an odd number of pillars are on a pillar line or when the amount of time to install roof support in a split is longer than the amount of time to mine the split, it may be advantageous to mine three pillars simultaneously. The split-and-fender process will be detailed in the material that follows. Figures 19 through 32, which illustrate the process, depict two pillars with sequential mining.

The overall cut sequence for split - and - fender pillar recovery is shown.

ROOF SUPPORT: Breaker posts have been placed at all openings to the gob. Roadways have been narrowed to 16 feet.

VENTILATION: Shown on individual cut illustrations.

HAULAGE: Locations of change-out points and haulage limitations will be discussed on the individual cut illustrations. Haulage paths are shown on the panel extraction plans detailed in Chapter 5.



Split-and-Fender Overall Cut Sequence

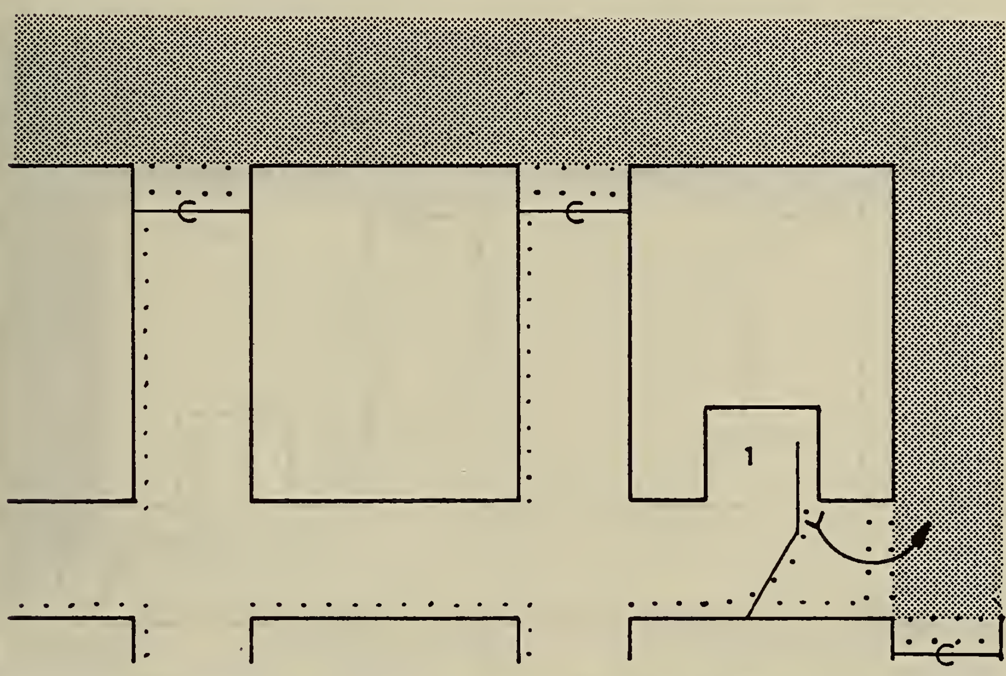
HO282021 Figure 19

The first cut in the split-and-fender process is shown in this figure. This cut will be made in the pillar closest to the gob. In order to avoid pillar pressure points, it is important to extract pillars from the gob side of the solid side of the panel.

ROOF SUPPORT: Turn posts are set across the crosscut leading into the split before Cut 1 is initiated.

VENTILATION: Placement of the face curtain is such that intake air sweeps the face of the split and returns through the gob.

HAULAGE: The placement of roof support and ventilation allows the change-out at the first intersection outby the working place. The position of the tailpiece on the miner may necessitate use of the next intersection outby during the early portions of this cut.



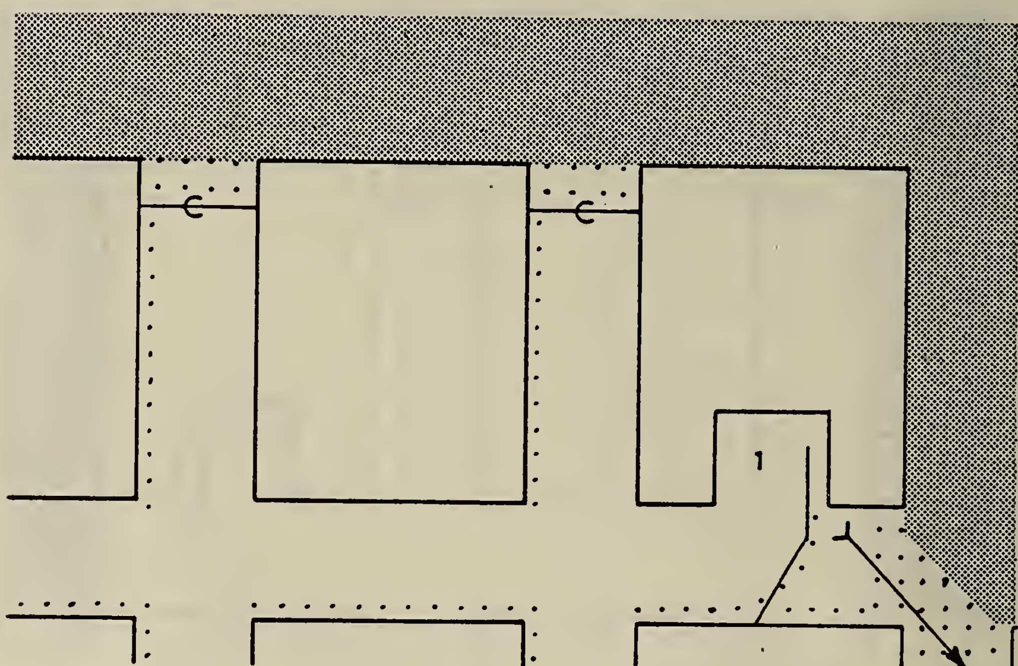
LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Split and Fender
Cut 1

HO282021 | Figure 20

The ventilation shown in Figure 24 is the preferred pattern; however, it will not work under some circumstances. In particular, that pattern is based on a gob that will draw a significant volume of air. If the conditions in the mine dictate that this is not the case, as is true of many mines with frail, unconsolidated shale immediate roof, the pattern shown here will have to be used. This change basically involves posting off the intersection inby the first split to allow return air to be drawn back through the inby entry. This figure will not be repeated but should serve as an example for mines operating under these conditions.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Split and Fender
Cut 1 - Alternate Ventilation

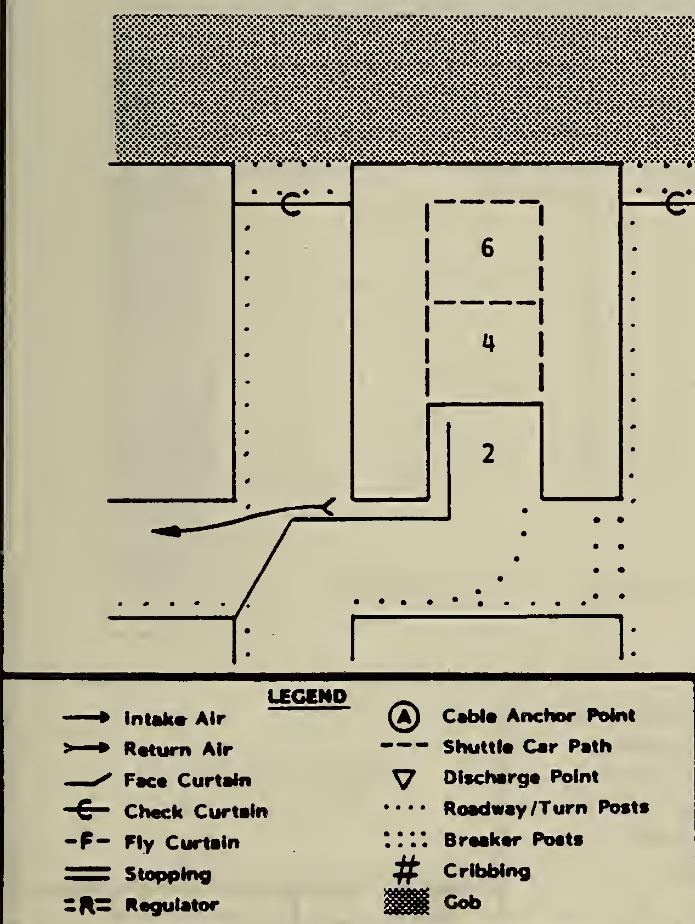
HO282021 | Figure 21

Cuts 2, 4, and 6 form the split in the outby pillar.

ROOF SUPPORT: Turn posts are set in the crosscut leading into the split. The breaker posts across the crosscut are not required for roof support but may be set to eliminate two trips by the timber crew. Roof bolting takes place in cuts 1, 3, and 5 while cuts 2, 4, and 6 are being mined.

VENTILATION: The only way to ventilate split and fender pillar extraction and avoid having workmen in dust is to use some form of double-split ventilation such as that shown. The return air from this pillar will vent into the panel return while the return air from the first pillar vents into the gob. Complete panel ventilation patterns for this technique are shown in detail in the next chapter.

HAULAGE: The change-out is in the second crosscut outby.



Split and Fender
Cuts 2, 4 and 6

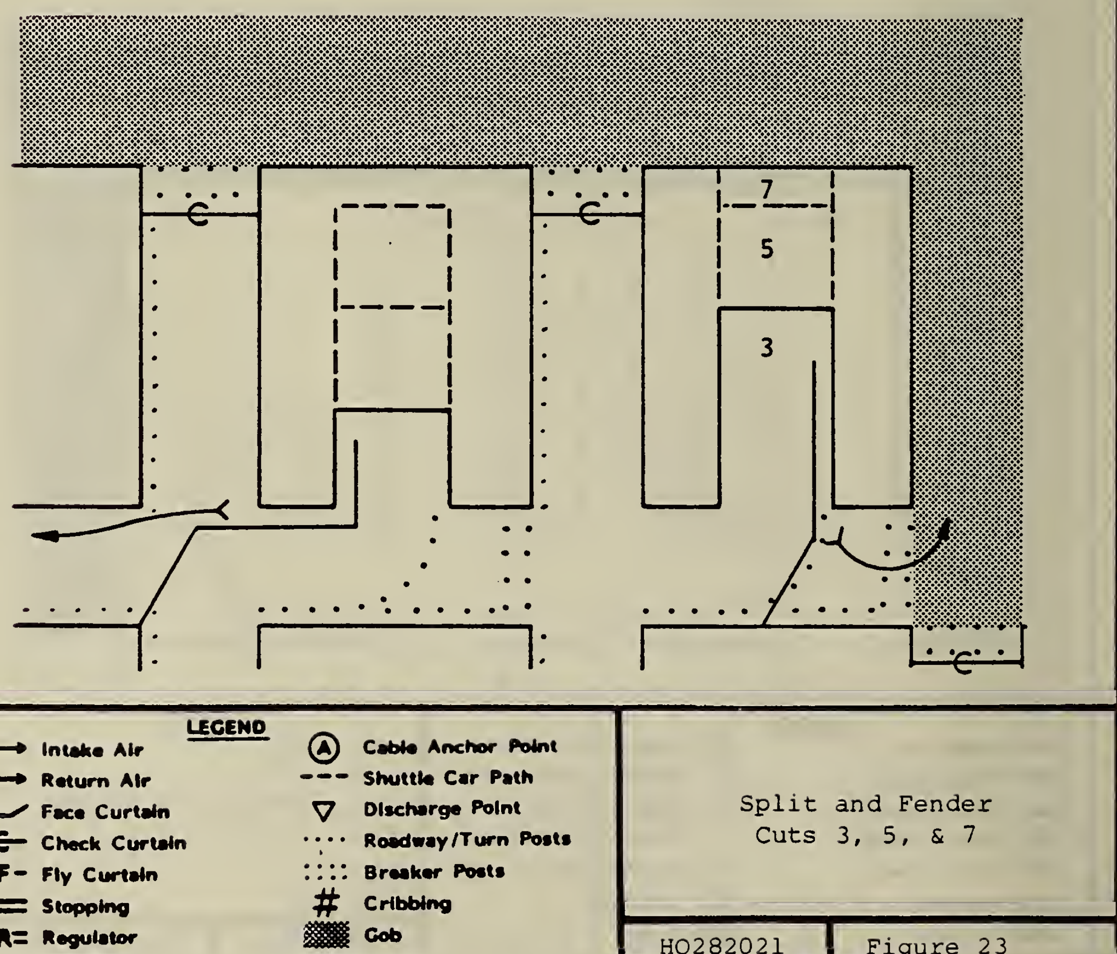
HO282021 | Figure 22

Cuts 3, 5, and 7 complete the split in the inby pillar.

ROOF SUPPORT: Cuts 3 and 5 are bolted after they are completed (during the mining of Cuts 4 and 6 respectively). Breaker posts will be placed across the end of the split after Cut 7 is completed.

VENTILATION: Same as Cut 1. The brattice curtain is advanced to stay within 10 feet of the face.

HAULAGE: The change-out is in the second crosscut outby.



Split and Fender
Cuts 3, 5, & 7

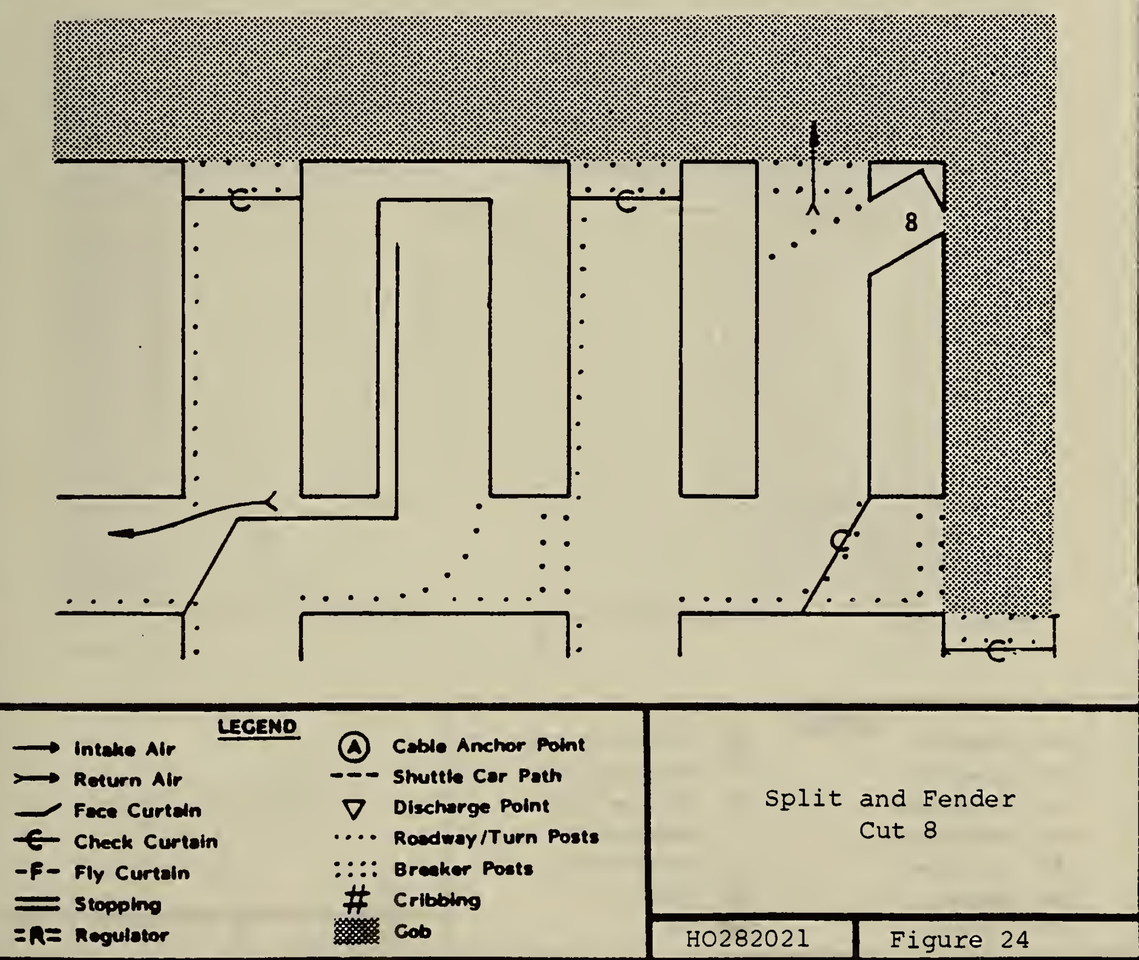
HO282021 Figure 23

Cut 8 is the first lift into the inby fender created by the completion of the split through the pillar.

ROOF SUPPORT: Breaker posts have now been set across the end of the split. A row of turn posts is set across the split leading into the active lift.

VENTILATION: The air will split and be directed through the split across the faces and into the gob. It may be necessary to place a curtain on the turn posts leading into the cut in order to direct air across the cut.

HAULAGE: Shuttle car paths and change-out points will be identical to those used previously for Cuts 3, 5, and 7.



Split and Fender
Cut 8

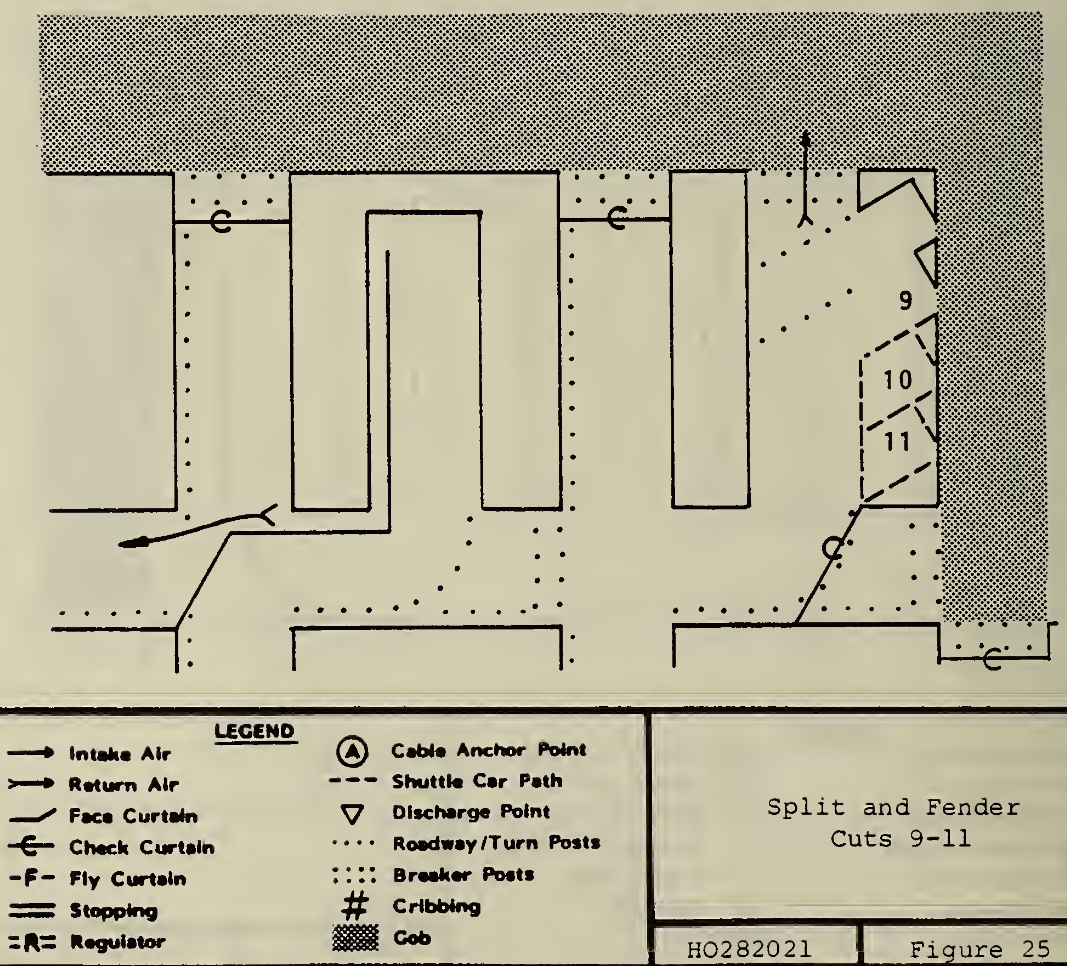
HO282021 | Figure 24

Cuts 9 through 11 complete the extraction of the first fender.

ROOF SUPPORT: Prior to the initiation of each cut, a row of turn posts is placed across the split leading into the cut. The turn posts for Cut 9 are shown below.

VENTILATION: Identical to Cut 8.

HAULAGE: Identical to Cut 8.



Split and Fender
Cuts 9-11

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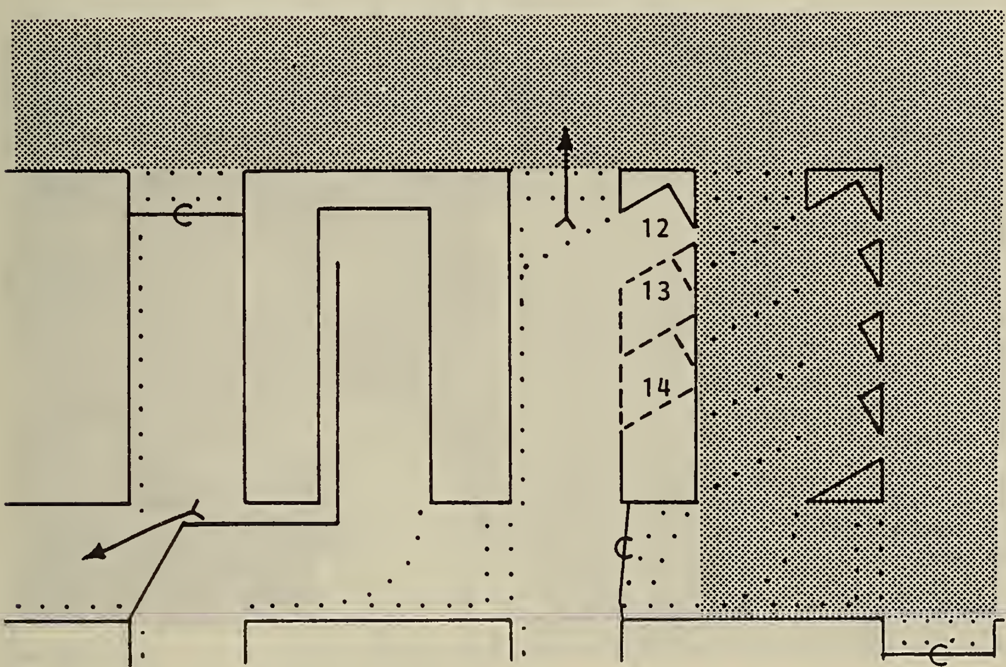
Figure 25

Cuts 12, 13, and 14 are made in the outby fender of the first pillar.

ROOF SUPPORT: Breaker posts are set across the crosscut leading into the area where mining was just completed. A row of turn posts is set across the entry leading into each cut. The turn posts for Cut 12 are shown below.

VENTILATION: The check curtain placed across the crosscut forces air through the entry. It may be necessary to place a curtain across the entry to direct air into the cuts.

HAULAGE: The change-out is in the second crosscut outby.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Split and Fender
Cuts 12-14

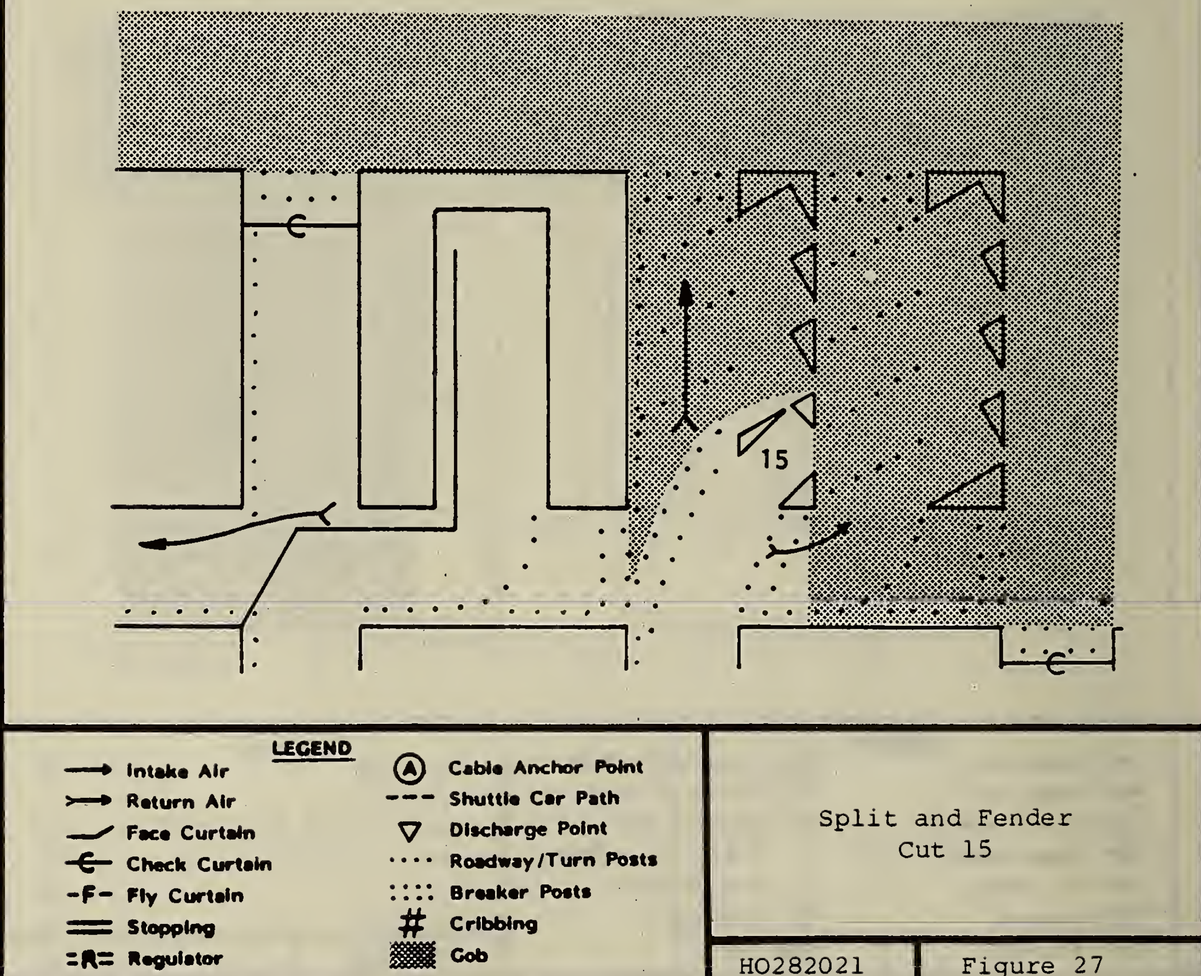
HO282021 | Figure 26

Cut 15 is the final cut (pushout) in the extraction of the first pillar.

ROOF SUPPORT: The installation of extra roof support is very important in the mining of the pushout. The roadway into the pushout must be narrowed to 14 feet using a row of breaker posts on each side of the roadway. One row of breaker posts will have been set after the completion of Cut 11. This was shown in the previous figure.

VENTILATION: Air coming through the entries will flow across this cut or through the split of the second pillar.

HAULAGE: Identical to Cuts 12-14.



Split and Fender
Cut 15

HO282021

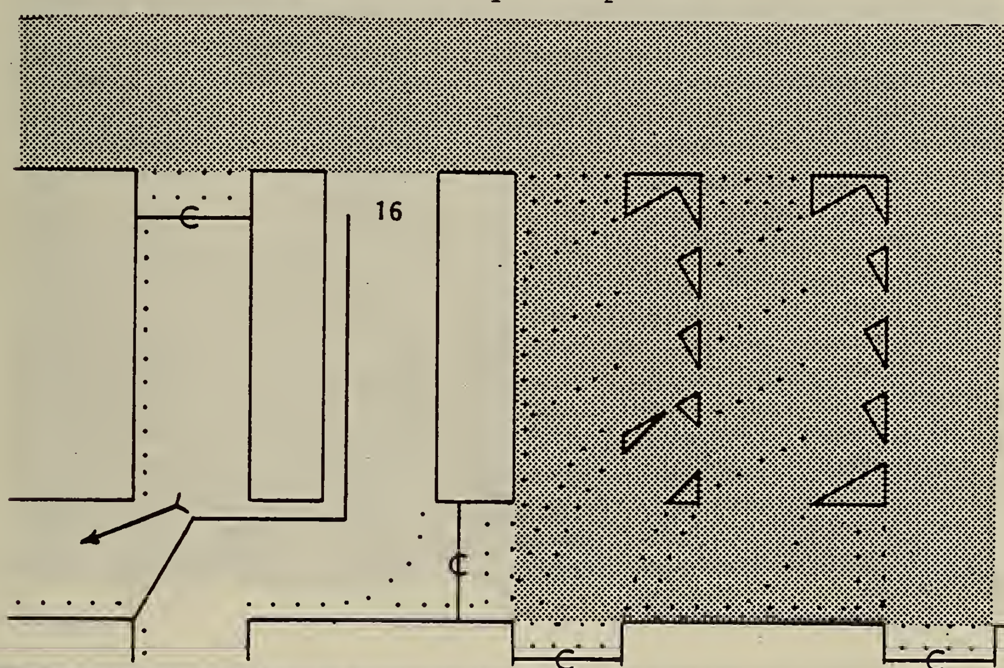
Figure 27

The 16th cut in the split-and-fender sequence is the completion of the split in the second pillar.

ROOF SUPPORT: After the pushout in the previous pillar is completed, the roadway will be posted with breaker posts and the area previously occupied by that pillar will be recognized as gob and no longer used as an active work area. Breaker posts will also be placed across the end of the split once it is completed.

VENTILATION: At the beginning of this cut, some of the air will be drawn through the split, behind the curtain, and back down the return. Once the split is broken through to the gob, air will also pass directly through into the gob. Check curtains were placed across the entry and crosscut into the area just completed.

HAULAGE: The change-out will be at the second crosscut outby the pillar.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Split and Fender
Cut 16

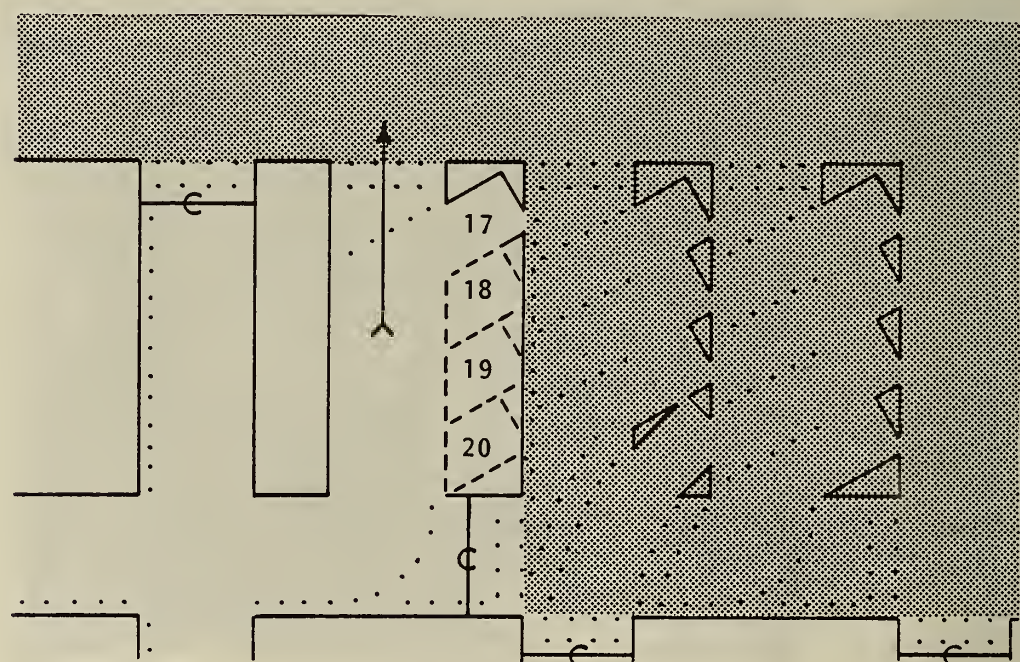
HO282021 Figure 28

Cuts 17-20 complete the extraction of the inby fender of the second pillar. These cuts are performed in an identical manner to Cuts 8, 9, 10, and 11 in the first pillar.

ROOF SUPPORT: The breaker posts placed after the split was completed can be seen in this figure. A row of turn posts will be placed leading into each cut. Turn posts are shown for Cut 17 only.

VENTILATION: Ventilation for all of these cuts will be directly up the split into the gob.

HAULAGE: The change-out is in the first crosscut outby.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Split and Fender
Cuts 17-20

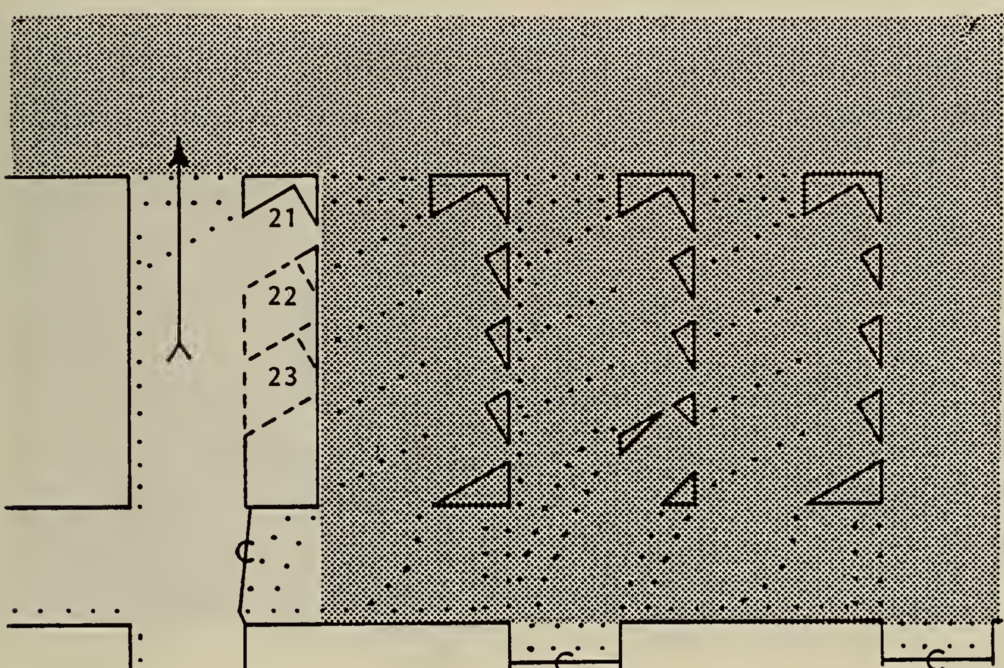
HO282021 | Figure 29

Cuts 21-23 are the first three cuts in the removal of the outby fender of the second pillar in the split-and-fender sequence.

ROOF SUPPORT: The row of breaker posts shown near the split in this pillar are set after completion of Cut 20 in the inby fender. A row of turn posts is placed prior to the initiation of each cut. The turn posts for Cut 21 are shown.

VENTILATION: Ventilation of these three cuts will be directly up the entry into the gob. The check curtain across the crosscut has been moved outby the split.

HAULAGE: The change-out is in the first crosscut.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Split and Fender
Cuts 21-23

HO282021

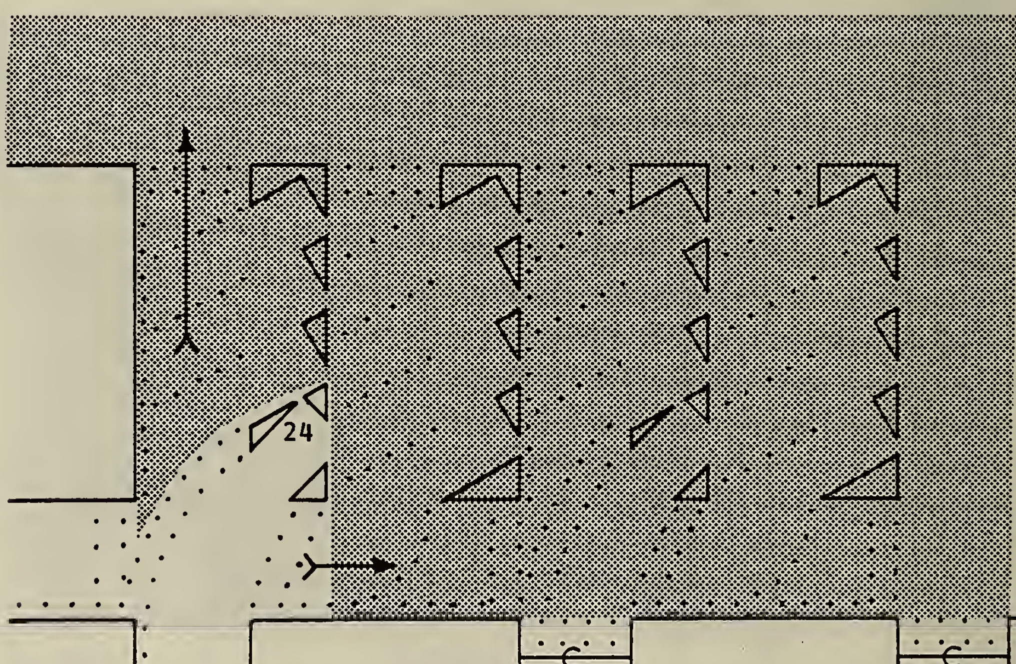
Figure 30

Cut 24 is the final pushout in the basic, two-pillar split-and-fender sequence.

ROOF SUPPORT: Prior to initiating this cut, roadway posts must be set to limit the roadway to a maximum of 14 feet. The breaker posts separating this area from the next pillar in the sequence must be set at this time as well. After this cut is completed, the entrance to the roadway should also have breaker posts set across it. These actions will effectively isolate the mined out area.

VENTILATION: Fresh air will flow directly across the working place into the gob.

HAULAGE: Because of the roadway limitation, it will be possible to access this cut only from the entry. The change-out will be in the second crosscut outby this area.



LEGEND

→	Intake Air	Ⓐ	Cable Anchor Point
≻→	Return Air	- - -	Shuttle Car Path
⁄	Face Curtain	▽	Discharge Point
-€-	Check Curtain	· · · ·	Roadway/Turn Posts
-F-	Fly Curtain	∷∷	Breaker Posts
═	Stopping	#	Cribbing
=R=	Regulator	▓	Gob

Split and Fender
Cut 24

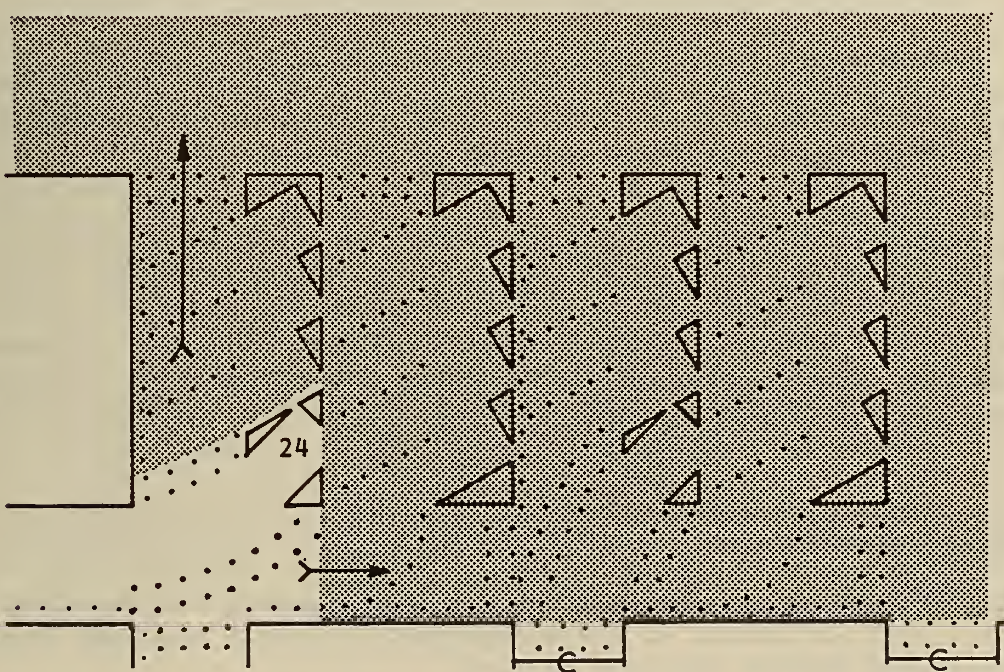
HO282021 | Figure 31

If access to the pillar through the entry is not possible, the alternative shown here, providing access through the crosscut, can be used.

ROOF SUPPORT: Breaker posts are placed across the entry. The intersection is timbered sufficiently to limit access to one 14-foot roadway.

VENTILATION: Fresh air will flow directly across the working place into the gob.

HAULAGE: The change-out is in the second crosscut entry.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Split and Fender
Alternate Cut 24

HO282021 Figure 32

Properties of the Process

Split and fender is the most commonly used pillar extraction process in the United States, primarily because of its adaptability and its simplicity. Split and fender is an adaptable process because it works with many different pillar sizes. The minimum fender width is generally 8 feet. The minimum split width is on the order of 10 feet. The maximum dimensions for width of the fenders and splits are approximately 13 feet and 20 feet, respectively. This means that it is possible to extract any pillar between approximately 26 and 46 feet wide using a single split. Wider pillars can be extracted using multiple splits, but in doing this, some of the advantages of the basic single split technique are lost. More commonly, when a larger pillar is required, the pocket-and-wing technique is used for extraction. Pillars of any length can be extracted with the split-and-fender process.

The simplicity of the sequence ensures that the sequence will normally be followed and that inadvertent deviations from the sequence will be infrequent. However, split and fender generally requires mining two pillars at the same time. Changeout points are usually one crosscut back from the active pillar, causing delays in haulage. Ventilation, particularly when double-splitting the air, is difficult.

Conditions of Usage

The split-and-fender process is used under a wide variety of conditions and with most mining equipment. The process is adaptable to most seam thicknesses and has been observed in seams from 40 inches to 25 feet. Split and fender can be practiced with conventional mining equipment and virtually all continuous miners (including some auger miners).

The split-and-fender process can be ideally used only in pillars of the specific dimensions discussed previously. Where larger pillars are required, the pocket-and-wing method is more appropriate.

Because of the versatility of the split-and-fender process, discussing the conditions under which it may not be the preferred process is more practical than discussing the conditions under which it is preferred. Several considerations could lead to preference of other methods, as follow:

1. Very large pillars (wider than 45 feet) are difficult to extract using split and fender.

2. Fragile roof may make it desirable to use a process that results in more rapid extraction of individual pillars rather than one requiring sequencing between multiple pillars.

3. The use of open ending may be desirable or more effective when using conventional mining equipment or under certain conditions. Split and fender also can be used with conventional equipment.

Common Areas of Usage

Split-and-fender extraction is the most common extraction process in all regions except the following:

1. Portions of Alabama where conventional mining predominates.

2. Portions of southern West Virginia and eastern Kentucky where very low coal (less than 36 inches) is prevalent.

3. The Pittsburgh seam in western Pennsylvania and parts of northern West Virginia where pocket-and-wing extraction is practiced.

The specific practices used in each coal seam can be found in appendix A.

Pocket and Wing

The pocket-and-wing pillar extraction process (also known as pocket and fender or pocket and stump) is used extensively in some areas. The following pages will describe the process, its properties, and the conditions of its frequent usage. Finally, the areas in which pocket and wing is practiced will be identified.

Description of the Basic Process

Pocket and wing is a process in which two or more working places can be sequenced within an individual pillar. The process is similar to the open ending process (see chapter 4), except that a wing or fender of coal is left on the gob side of the pocket to help support the roof. When the pocket is completed, the wing can be recovered during retreat from the pocket.

The following pages illustrate a detailed, step-by-step sequence of cuts for a pillar being extracted by the pocket and wing process. The optimum pillar dimensions can be determined according to the techniques described in the section of chapter 6 entitled "Pillar Dimensioning." Any number of pockets can be driven through a pillar depending upon the overall dimensions. For simplicity in the discussions that follow, the pillar has been restricted to a size requiring only two pockets.

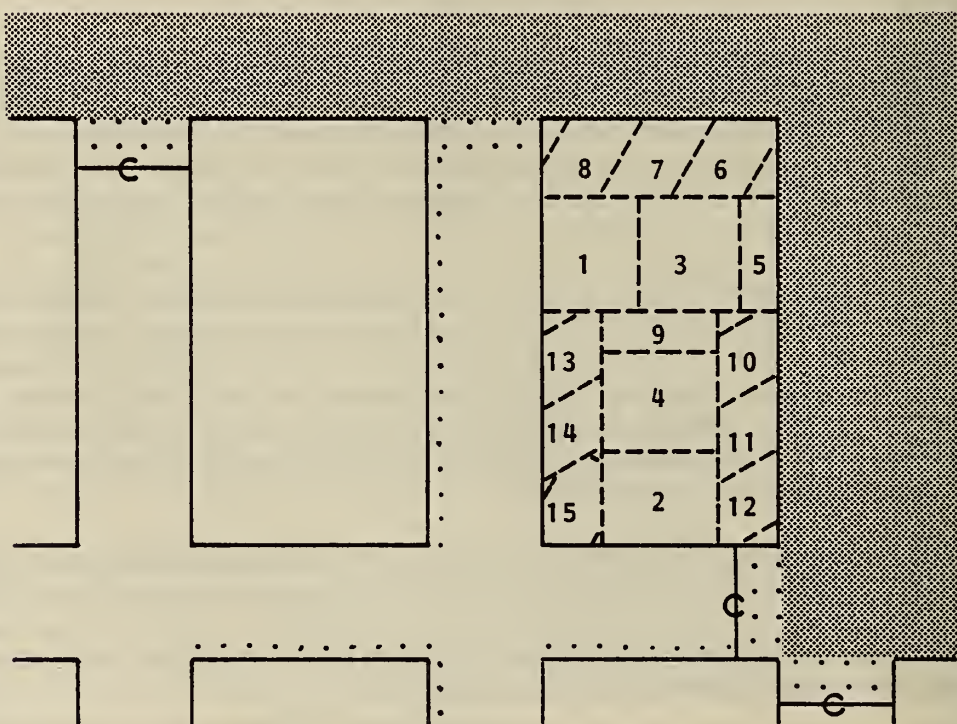
The pocket and wing method allows two working places within a single pillar, thus eliminating long delays caused by sequencing between pillars. Changeout points can be located at the active pillar. Ventilation using single split air is a simple process. The specific steps in the extraction process are shown in figures 33 through 42.

This figure shows the overall cut sequence for pillar extraction using the pocket-and-wing process.

ROOF SUPPORT: Breaker posts are set at all openings to the gob. Roadways have been narrowed to 16 feet.

VENTILATION: This is shown on individual cut illustrations.

HAULAGE: Change-out points and haulage limitations will be discussed on the individual cut illustrations.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket-and-Wing
Overall Cut Sequence

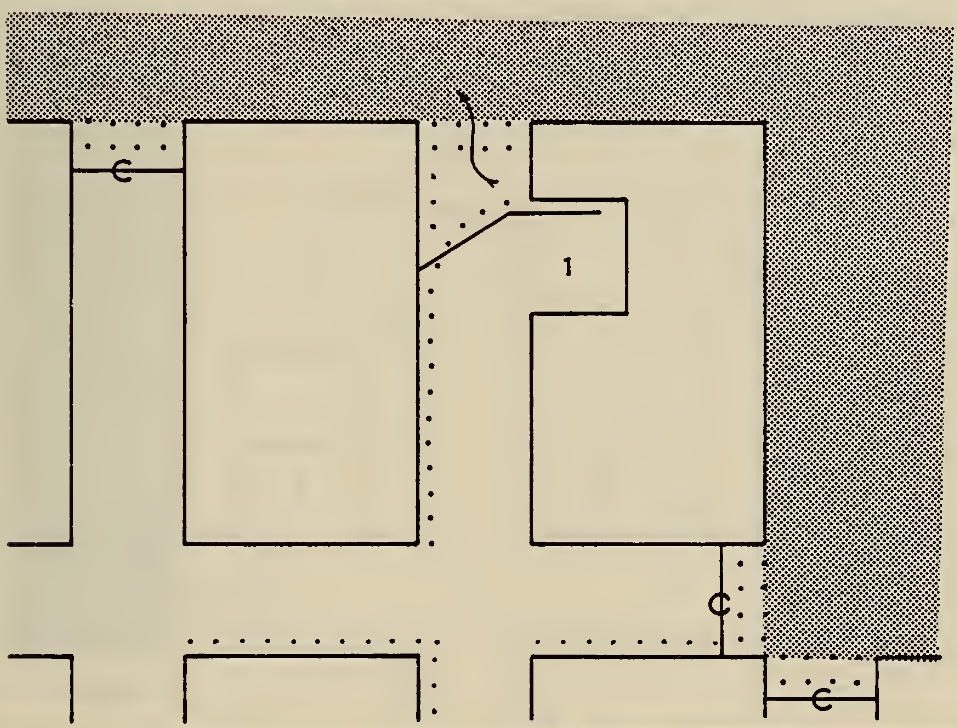
HO282021 | Figure 33

Cut 1 is the first cut of the first pocket. It is started on the long side of the pillar.

ROOF SUPPORT: Turn posts will be set prior to initiation of the cut.

VENTILATION: Airflow is across the face, behind the face curtain, and out into the gob.

HAULAGE: The change-out point is at the first intersection.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- F Fly Curtain
- Stopping
- R Regulator
- A Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket and Wing
Cut 1

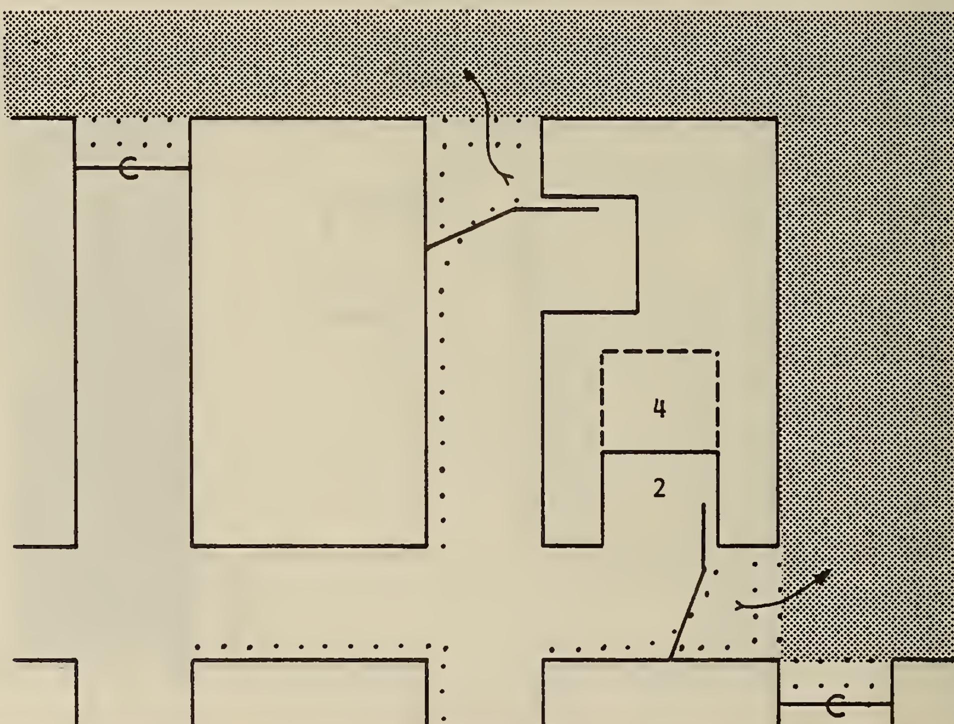
HO282021 | Figure 34

Cut 2 is the first cut of the second pocket. It is started into the narrow side of the pillar. Roof support, ventilation, and haulage characteristics for Cut 4 are identical to those of Cut 2.

ROOF SUPPORT: While Cut 2 is being mined, Cut 1 is being roof bolted. Turn posts will be set prior to starting Cut 2.

VENTILATION: The check curtain already in the crosscut is extended for use as a face curtain. Airflow is across the face, behind the curtain, and out into the gob. Air volume is regulated at the face by the amount of opening in the curtains.

HAULAGE: At the start of Cut 2, the miner's tail-piece extends into the intersection, forcing the change-out points to be located at the next crosscut outby.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket and Wing
Cuts 2 and 4

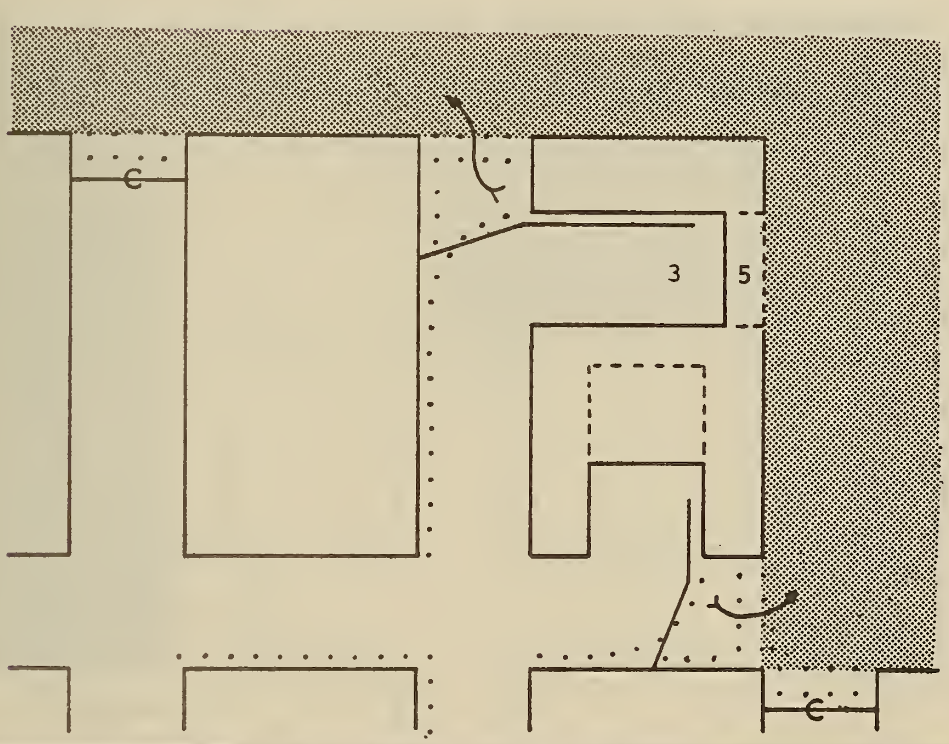
HO282021 | Figure 35

Cut 3 is the continuation of the first pocket. Cut 5 will complete the pocket through to the gob.

ROOF SUPPORT: As Cut 3 is being mined, Cut 2 is being bolted. Breaker posts will be set across the opening to the gob after Cut 5 is completed. Cut 5 does not have to be bolted.

VENTILATION: The brattice curtain is kept within 10 feet of the face as Cuts 3 and 5 are advanced.

HAULAGE: Same as Cut 1.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket and Wing
Cuts 3 and 5

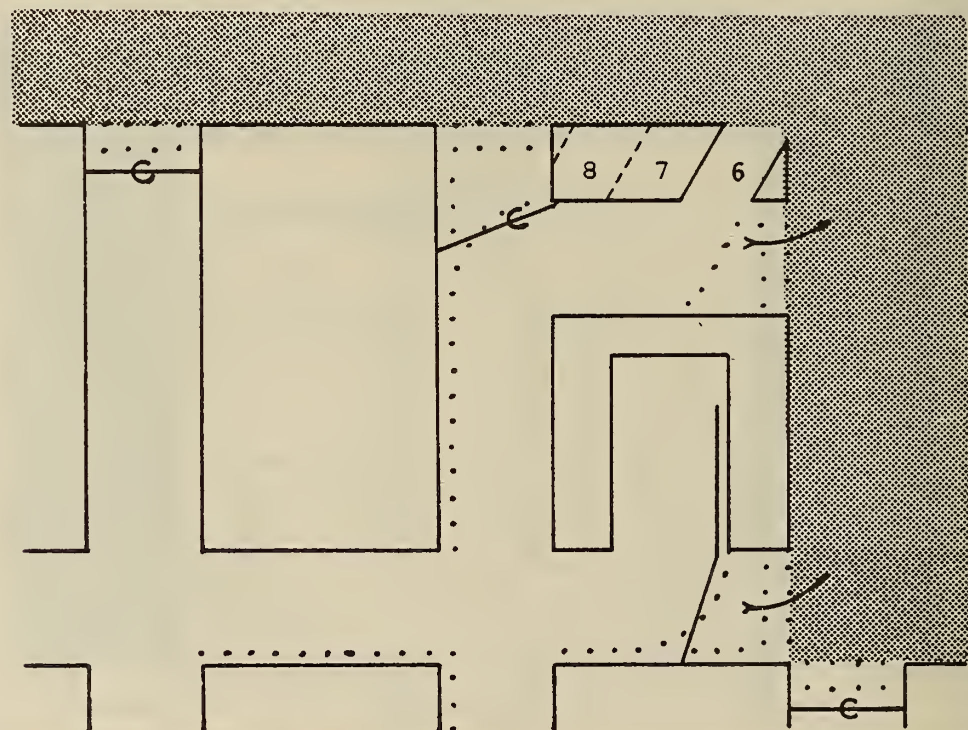
HO282021	Figure 36

Cut 6 is the first lift from the first wing. Cuts 7 and 8 complete the first wing. Since the operator is on the far side of the miner from the wing, increasing the miner's reach, all of the wing can be extracted.

ROOF SUPPORT: Breaker posts are set across the completed pocket. Turn posts are set leading into each cut. Only the turn posts for Cut 6 are shown.

VENTILATION: Airflow is into the pocket, across the face, and into the gob. It may be necessary to use a face curtain on the turn posts to direct air into the face.

HAULAGE: Same as Cut 5.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket and Wing
Cuts 6, 7 and 8

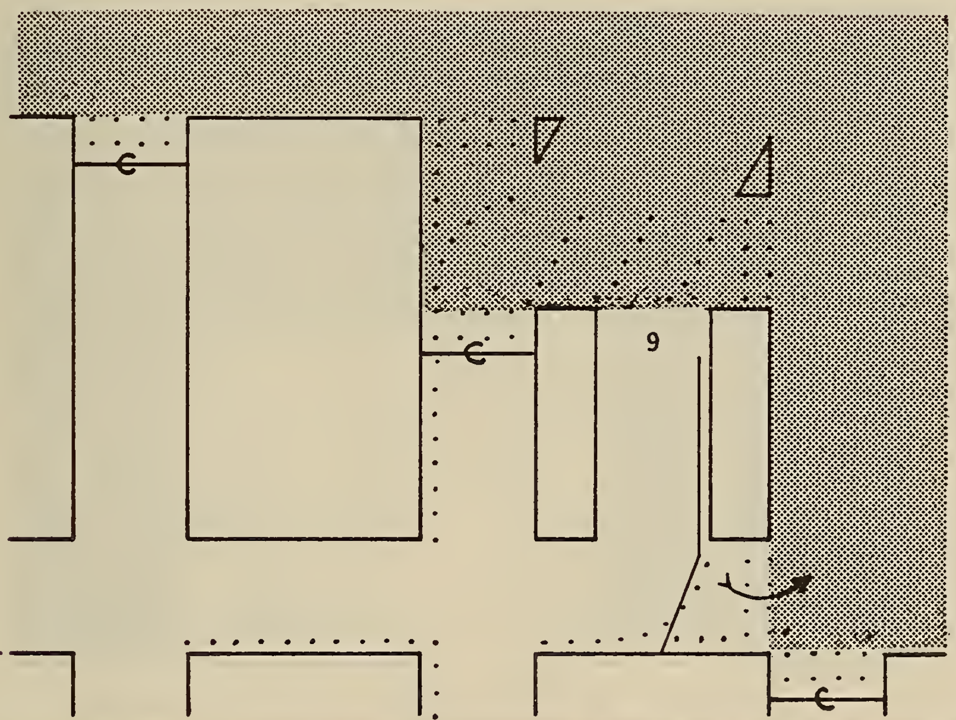
HO282021 | Figure 37

Cut 9 is the breakthrough cut of the second pocket.

ROOF SUPPORT: Breaker posts are set in the entry outby the entry pocket and the wing that was just completed. Breaker posts will also be set across the crosscut pocket when cut 9 is completed.

VENTILATION: A check curtain is installed outby the breaker posts in the entry. The face curtain in the pocket is kept within 10 feet of the face until the cut breaks through into the gob.

HAULAGE: Same as Cut 4.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket and Wing
Cut 9

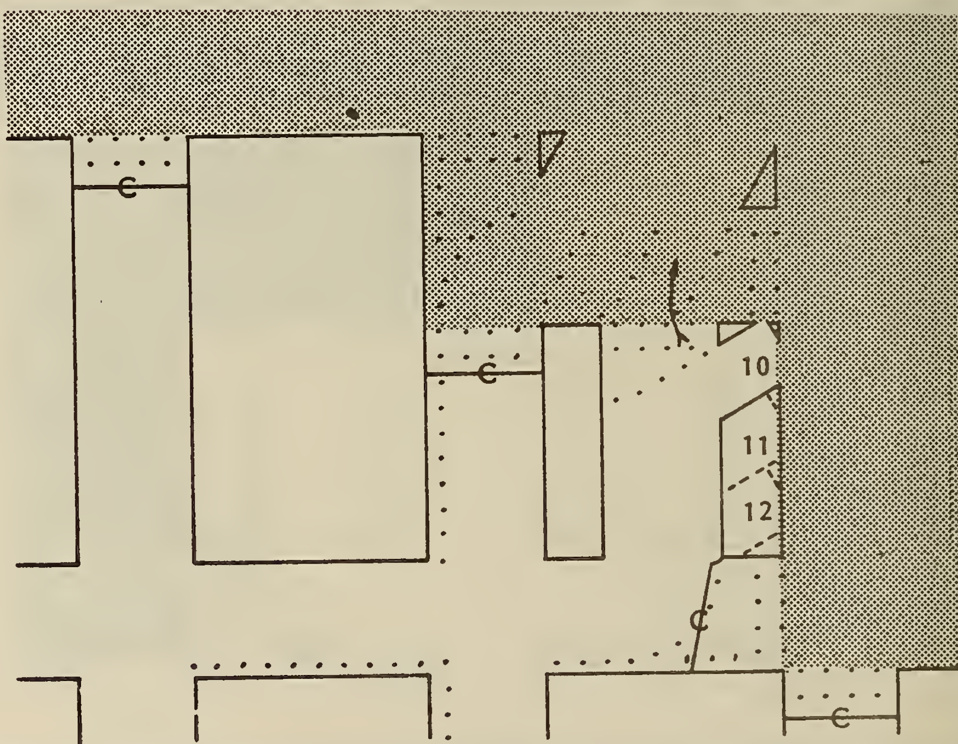
HO282021 | Figure 38

Cuts 10-12 extract the inby wing off the crosscut pocket.

ROOF SUPPORT: Cut 10 is started after Cut 9 has been completed and breaker posts set. Turn posts are set leading into each cut. Only the turn posts for Cut 10 are shown.

VENTILATION: For this wing and the next, the miner operator is on the outby side of the miner, thereby limiting the reach of the miner. Airflow is across the face into the gob.

HAULAGE: Same as Cut 9.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket and Wing
Cuts 10-12

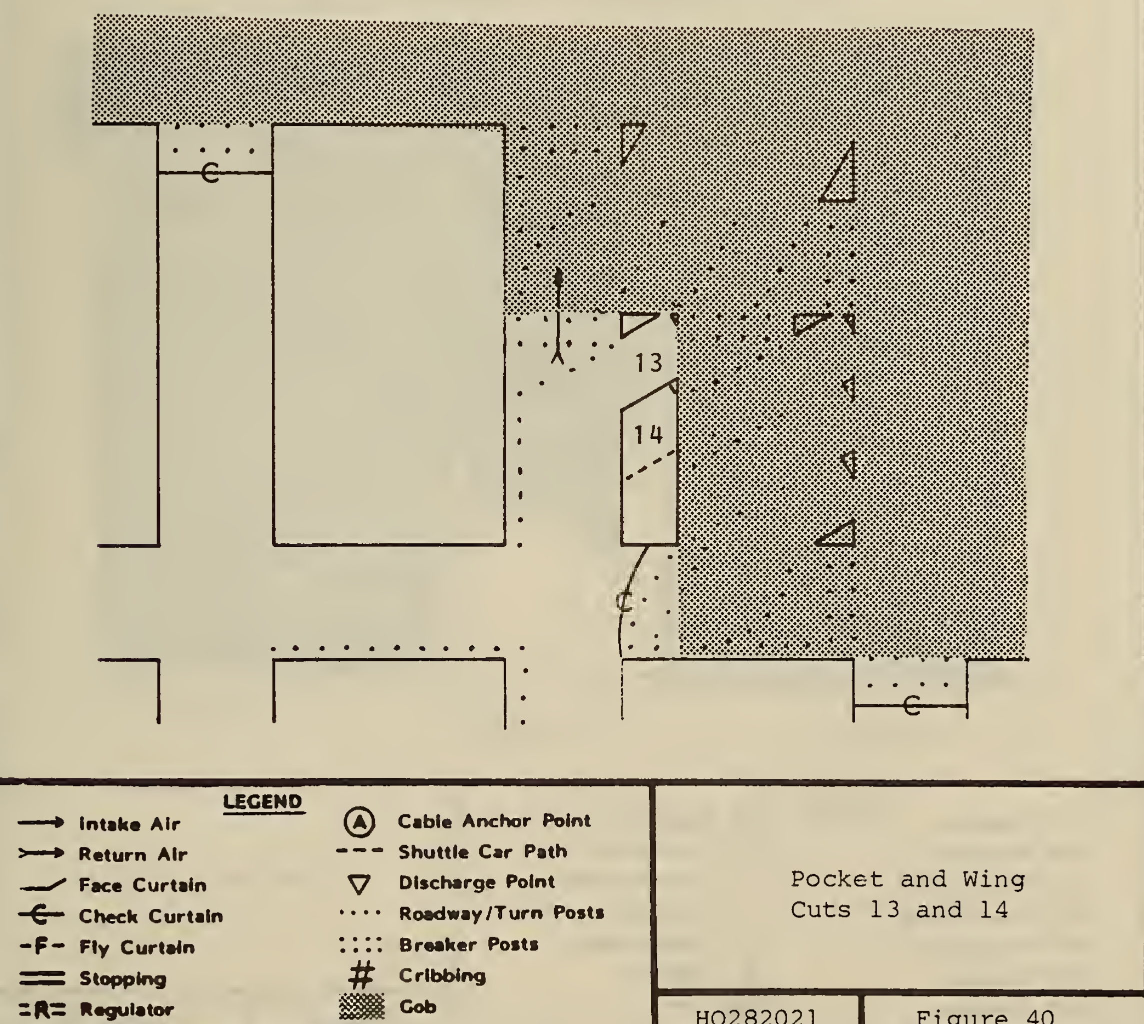
HO282021 | Figure 39

Cuts 13 and 14 initiate removal of the left (and last) wing.

ROOF SUPPORT: The opening used for access to the wing just finished is sealed off by breaker posts. Note that breaker posts are set so that they can also be used for the pushout stump. Turn posts are set leading into each cut. The turn posts for Cut 13 only are shown.

VENTILATION: The check curtain, previously located across the entry, is removed. A check curtain is installed outby the breaker posts just set in the crosscut. Airflow is similar to that of Cut 8.

HAULAGE: The change-out point can be located in the intersection.



Pocket and Wing
Cuts 13 and 14

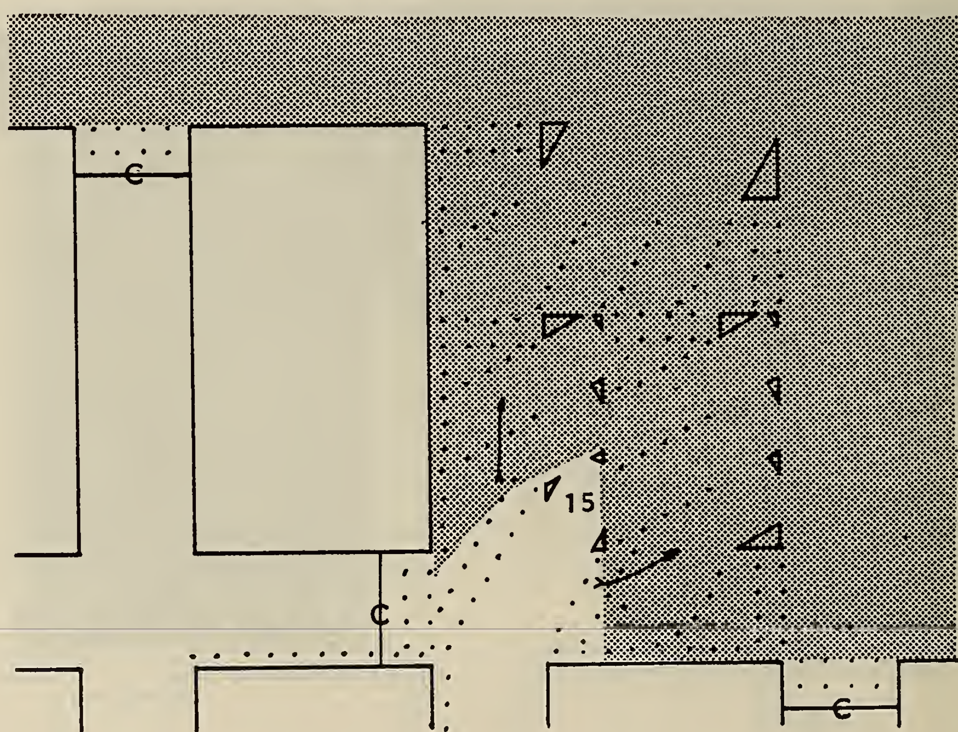
HO282021 Figure 40

Cut 15 is the pushout. If conditions do not permit the use of the entry as a haulageway (as shown here), the crosscut may be used and the entry posted off as shown in the next figure.

ROOF SUPPORT: As protection for the roadway leading into this lift, breaker posts are set on both sides of the roadway. Breaker posts are also set in the crosscut outby the intersection.

VENTILATION: The check curtain previously hung in the crosscut is removed. A check curtain is installed in the crosscut. Air passes both sides of the pushout and into the gob.

HAULAGE: Haulage is restricted to one 14-foot-wide roadway. The change-out must be located at the second crosscut outby.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Pocket and Wing
Cut 15

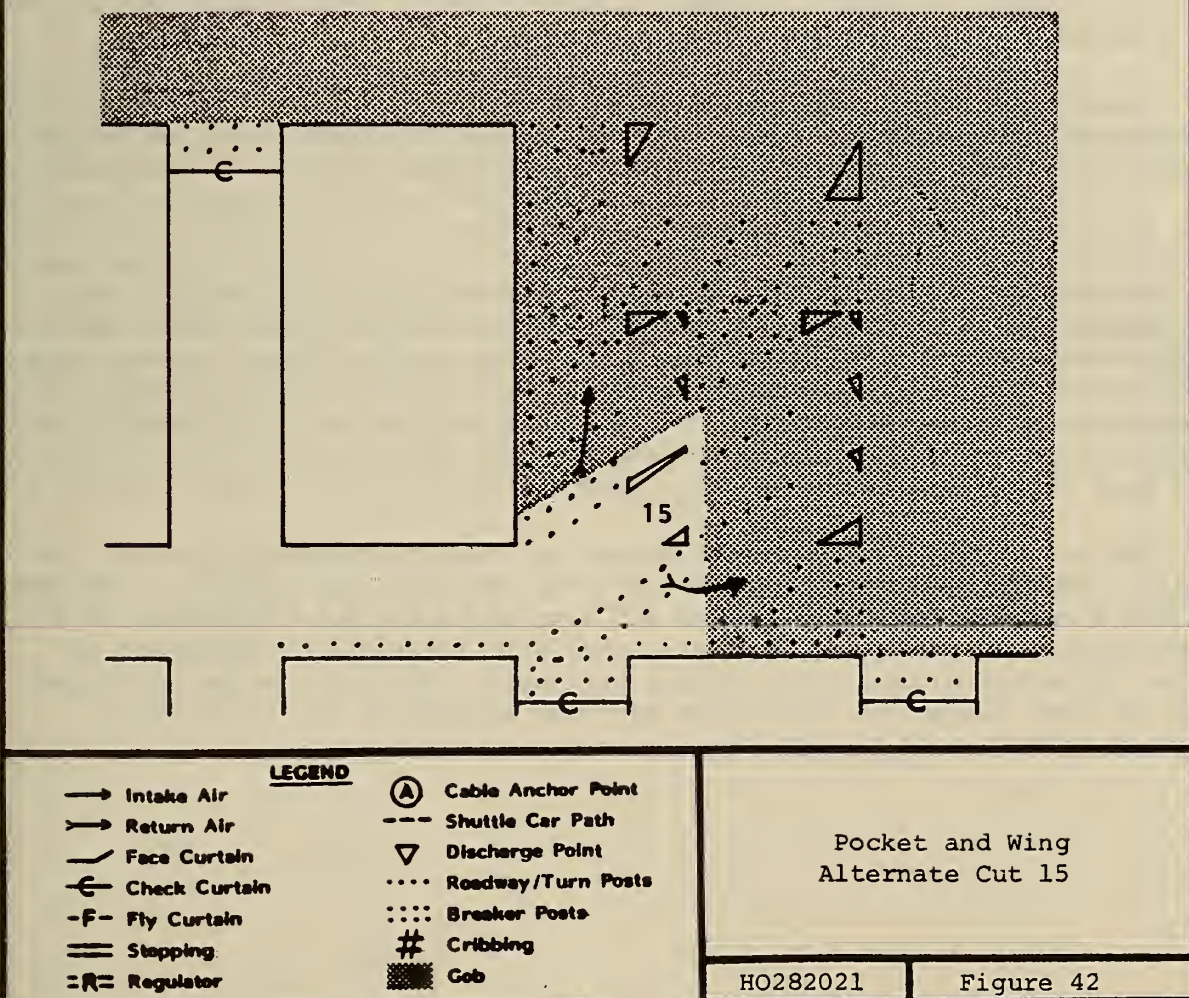
HO282021 Figure 41

If access to the pushout through the entry is not possible, the crosscut may be used as shown in this figure.

ROOF SUPPORT: The roadway into the pushout is protected by a double row of breaker posts on each side. Breaker posts are also set across the entry.

VENTILATION: A check curtain is hung in the entry outby the breaker posts just set. Air flows by both sides of the pushout stump and into the gob.

HAULAGE: A single 14-foot wide roadway leads into the pushout. The change-out must be located at the second crosscut back.



Pocket and Wing
Alternate Cut 15

HO282021 Figure 42

Properties of the Process

There are several important properties of the pocket-and-wing extraction process. The first is its adaptability to large pillars. Most of the other pillar extraction processes have limitations on the maximum width of the pillar. State regulations sometimes limit the maximum dimensions for pillar design, but the regulated maximum dimensions are usually greater than the maximum pillar dimensions necessitated by equipment limitations. Pocket-and-wing extraction is applicable over a wide range of sizes if large pillars are necessary or are preferred.

The second property is the ability to sequence cuts within the same pillar. This allows a greater concentration of working places than with most other processes. The sequence of cuts for removal of a single pillar rather than sequencing cuts between a number of pillars is often preferable because of the shorter exposure time within a particular pillar.

Another property of the pocket-and-wing process is that the operations take place from two different entries. This provides protection by having a solid pillar outby the pocket at all times.

Ventilation with the pocket-and-wing process is easier than with the split-and-fender process. In areas where the use of double-split ventilation is difficult, this property is quite a benefit.

Haulage with the pocket-and-wing process is also easier than with the split-and-fender process. The changeout points can normally be located at the pillar rather than one crosscut outby. This reduces delays in mining.

Conditions of Usage

Pocket-and-wing extraction is adaptable to virtually all conditions. Currently, its use is limited primarily to areas of deep cover where large pillars are necessary for support. It has also been utilized in areas where roof conditions do not permit long exposure times. An important design consideration in any mine plan is to select a process that will provide for rapid extraction of a pillar once recovery has begun. Pocket and wing may be the best choice in conditions where time within a pillar is very limited.

Another reason for the use of pocket and wing is the preference of the mining company. Initially, pocket and wing may have been chosen as the best method known at that time. Pocket and wing may have been introduced as a modification of the open-ending plan used with conventional equipment as mines converted to continuous mining equipment. Its success has continued its use even though the conditions may have changed to the point where another method would be superior.

Pocket and wing may not be desirable if the character of the coal is such that energy storage occurs from great pressure concentrations (such as from overburden, poor pillar design or alinement, or multiple seam mining), producing bump conditions. Energy releases in these pillars usually occur along the long side of the pillar, where miners frequently work during pocket-and-wing extraction. Specific techniques to be employed under bump conditions are discussed in chapter 6.

Areas of Usage

The Pittsburgh seam in western Pennsylvania and northern West Virginia is the principal area where pocket-and-wing extraction is used. It is also found in areas scattered throughout Pennsylvania. Detailed information on other areas can be found in the appendix.

Outside Lifts

The pillar extraction process of mining outside lifts is formally used by only a few mines in the country. However, it is a good technique for extraction of room pillars and is also used extensively in partial pillar extraction.

Description of the Basic Process

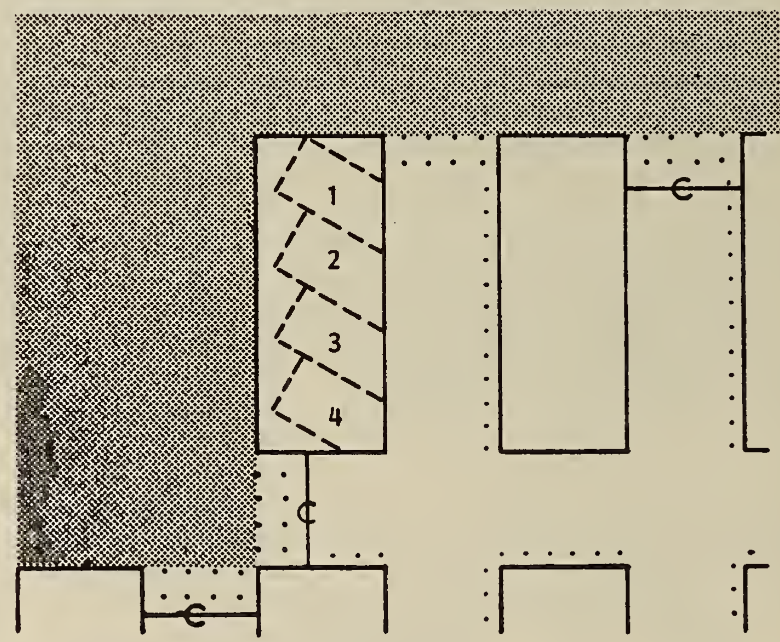
The outside-lift extraction process is primarily utilized to extract long, thin pillars (on the order of 20 by 50 feet). The cut sequence is similar to that required to remove the fenders or wings of the processes discussed earlier. While more roof bolting is required during the developmental phase, the retreat phase requires no roof bolting at all. This frees the crew to handle timbering requirements, allowing for a smoother work cycle. This technique cannot be used for the extraction of chain pillars because mining conditions are unlikely to permit leaving 20-foot-wide pillars for any substantial length of time. A typical application of this process would be in the extraction of small production pillars created when rooms are driven to the side of a panel (with the larger chain pillars extracted using split and fender or pocket and wing). The specific steps in the extraction process are shown in figures 43 through 47.

The overall sequence of cuts for pillar extraction by taking outside lifts is shown below.

ROOF SUPPORT: Breaker posts have been set at all entrances to the gob.

VENTILATION: This is shown on individual cut illustrations.

HAULAGE: Change-out points and haulage limitations are discussed on the individual cut illustrations.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Outside Lifts
Overall Cut Sequence

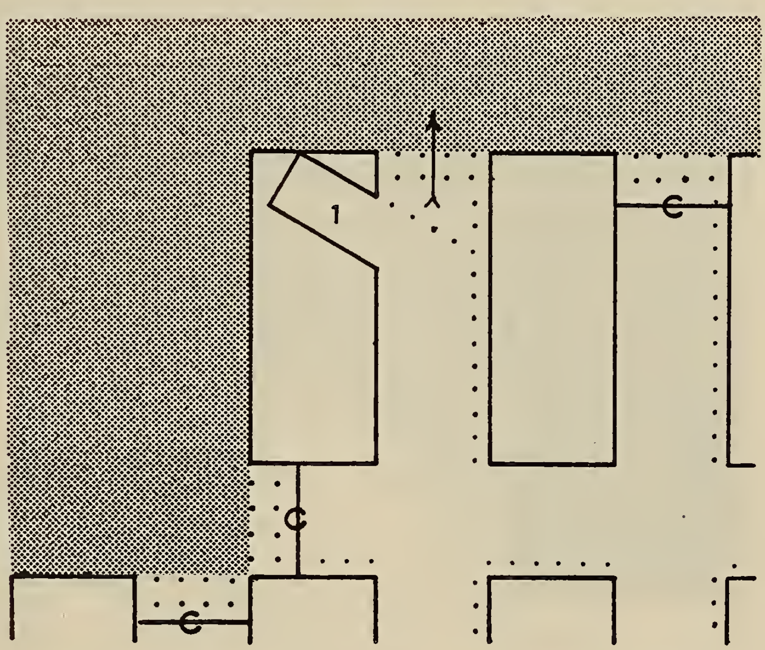
HO282021 | Figure 43

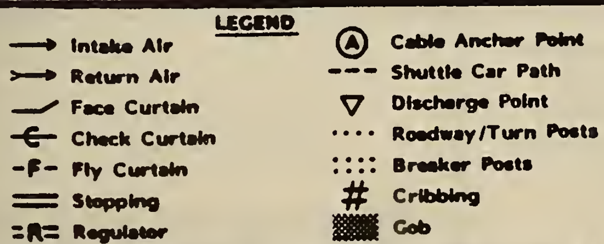
Cut 1 is the first lift.

ROOF SUPPORT: Prior to initiating the cut, a row of turn posts should be placed leading into the lift.

VENTILATION: Airflow is through the entry and into the gob. It may be necessary to place a face curtain on the turn posts to direct air into the cut.

HAULAGE: The change-out can be located at the first intersection.





Outside Lifts
Cut 1

HO282021

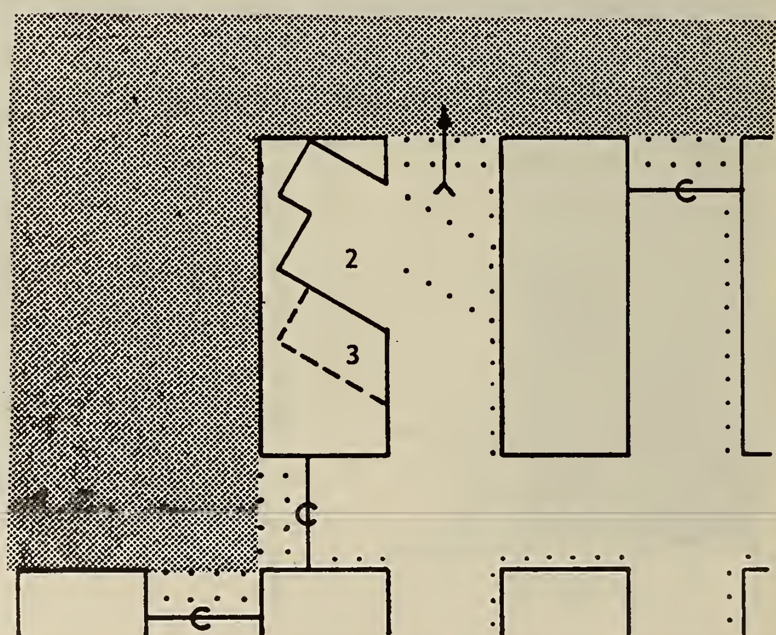
Figure 44

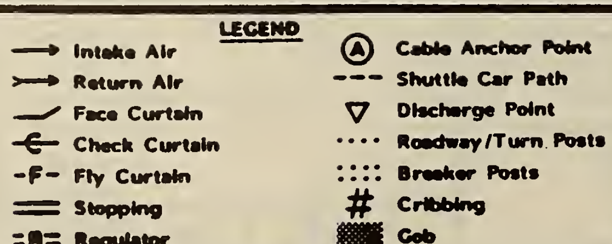
Cuts 2 and 3 extract the bulk of the pillar.

ROOF SUPPORT: Turn posts are set across the entry prior to starting each cut. Turn posts are shown for Cut 2 only.

VENTILATION: Same as Cut 1.

HAULAGE: Same as Cut 1.





Outside Lifts
Cuts 2 and 3

HO282021

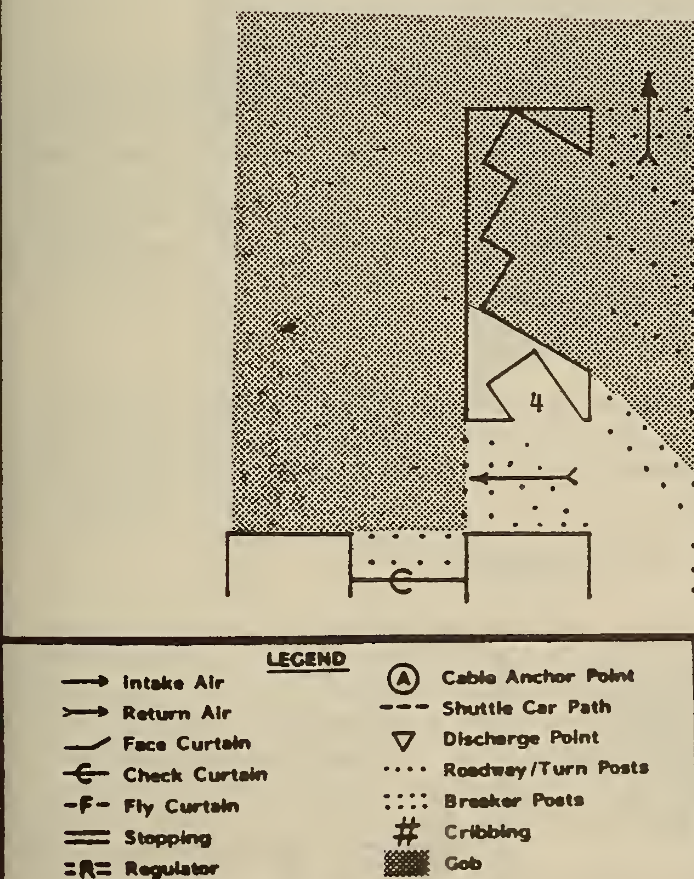
Figure 45

Cut 4 is the pushout lift of the pillar.

ROOF SUPPORT: Breaker posts are set on both sides of the roadway leading to the pushout and across the crosscut, outby the intersection.

VENTILATION: The check curtain in the crosscut inby the intersection is withdrawn. A check curtain is installed in the crosscut outby the intersection and breaker posts.

HAULAGE: Haulage is limited to one 14-foot-wide roadway through the entry. The changeout point is located in the second intersection outby the pillar.



Outside Lifts
Cut 4

HO282021

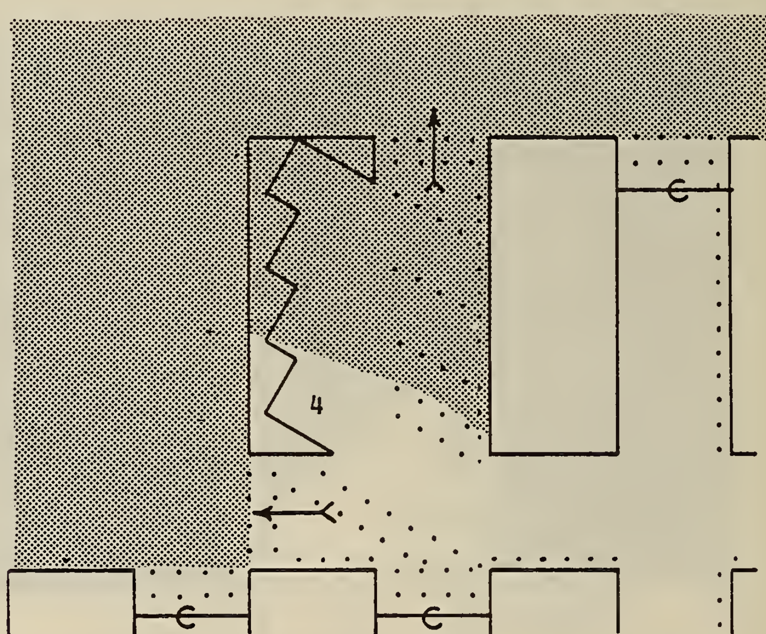
Figure 46

In the event that the entry is blocked for some reason such as a roof fall, an alternative path through the crosscut may be required. This is shown below.

ROOF SUPPORT: Breaker posts are set on both sides of the roadway leading to the pushout and across the entry outby the intersection.

VENTILATION: The check curtain in the crosscut outby the intersection is withdrawn, and a check curtain is installed in the entry outby the intersection.

HAULAGE: Haulage is restricted to the crosscut inby the intersection. The change-out must be one crosscut outby the pillar. One 14-foot-wide roadway leads into the cut.



LEGEND

Intake Air	Cable Anchor Point
Return Air	Shuttle Car Path
Face Curtain	Discharge Point
Check Curtain	Roadway/Turn Posts
Fly Curtain	Breaker Posts
Stopping	Cribbing
Regulator	Gob

Outside Lifts
Alternate Cut 4

HO282021 | Figure 47

Properties of the Process

The primary property of the outside-lift process is its suitability for small pillars in which lifts need not be bolted. The advantage is that a bolting machine and crew are not generally required during retreat operations except for spot bolting. This eliminates the need to sequence the miner and bolter between two or more places, therefore reducing the time it takes to extract a pillar. In addition, this also concentrates most of the operation within one area, making it easier to manage. Complete extraction can usually be attained since the continuous miner can extract the whole pillar in a quick series of small moves. The only delays are for setting timbers for the operator's protection.

Conditions of Usage

In general, since the process is limited to small pillars, only areas of low cover not requiring large pillars can utilize outside lifts. However, this process has been used under very deep cover where small, yieldable pillars are desired (such as in bump-prone areas).

The pillar extraction plan permits relatively quick recovery, thereby allowing its use where roof conditions are competent for only short periods of time. The process generally allows the miner to get into the pillar, mine it out with only a few short interruptions, and get out before any problems or dangerous conditions develop.

Areas of Usage

The outside-lift process is used in some mines scattered throughout the Appalachian coalfields. It is generally (but not always) found in mines having low cover that permits the safe use of small pillars. Locations in which outside lifts are used are the Pocahontas No. 3 seam in southern West Virginia and the Freeport seams in northeast West Virginia and west-central Pennsylvania. More detailed information concerning specific areas of usage can be found in the appendix.

Open Ending

The open-ending pillar extraction process is still used by quite a few mines throughout the country. This process is used in mines that utilize conventional mining equipment, although not all conventional mines practice open ending.

Description of the Process

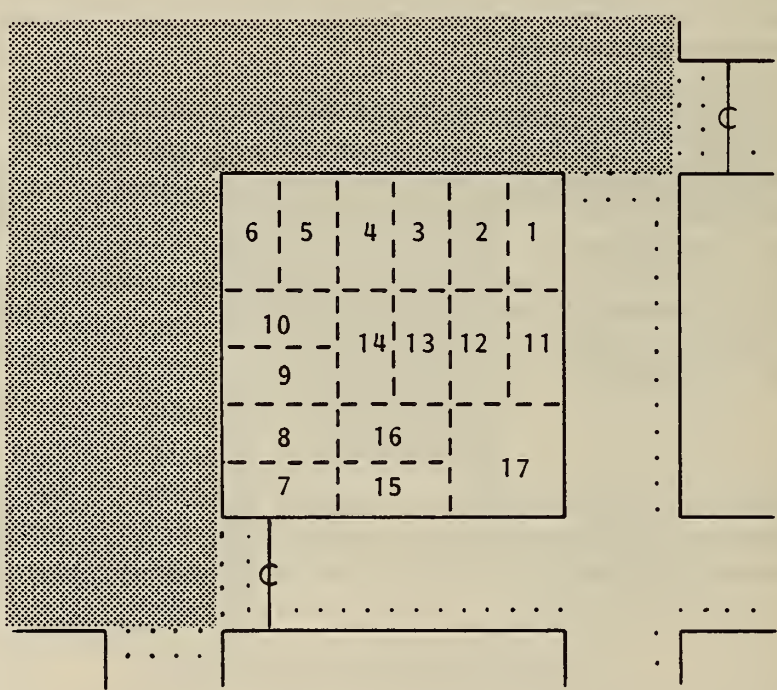
Open ending is a pillar extraction process in which a sequence of cuts is taken from one or more sides of a pillar. Since the process is used with conventional mining, the same cut is mined from each pillar in the pillar line to provide the necessary working places. Figures 48 through 57 show the cut sequence for only one of the pillars in the pillar line. The numbers indicate the order of cuts taken within the pillar, not the actual cut sequence as in the other processes described.

The overall cut sequence for pillar removal using the open-ending process is shown below. Conventional mining equipment is utilized and a 45-degree angled pillar line is used; therefore, sequencing will take place simultaneously in all pillars on the pillar line.

ROOF SUPPORT: Breaker posts have been set at all openings to the gob. All roadways have been narrowed to 14 feet.

VENTILATION: Shown on individual cut illustrations.

HAULAGE: Change-out points and haulage limitations will be discussed on the individual cut illustrations.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- -F- Fly Curtain
- Stopping
- =R= Regulator
- (A) Cable Anchor Point
- --- Shuttle Car Path
- ▽ Discharge Point
- .... Roadway/Turn Posts
- :::: Breaker Posts
- # Cribbing
- Gob

Open-Ending
Overall Cut Sequence

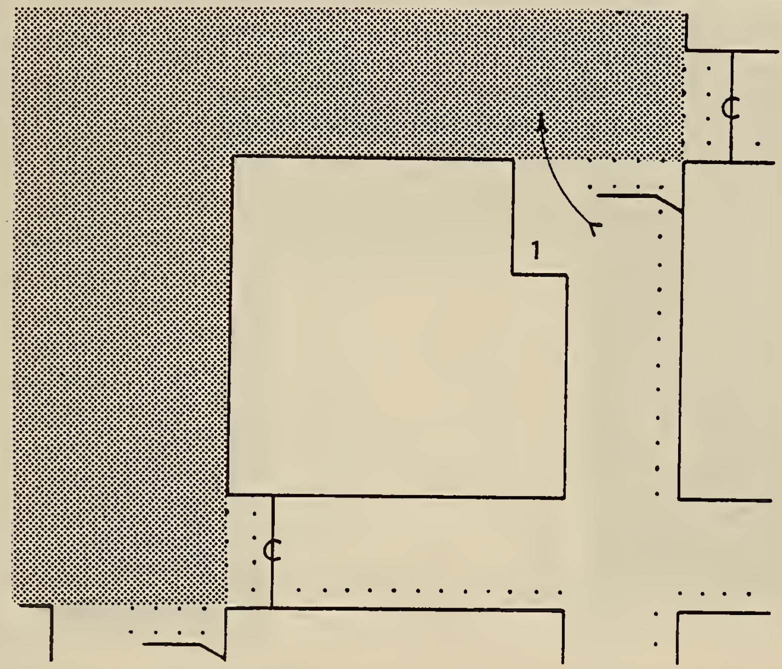
HO282021 | Figure 48

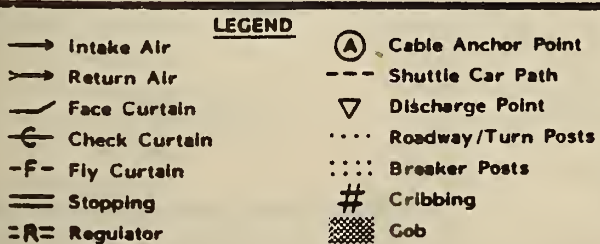
Cut 1 is the first cut taken from each pillar in the pillar line. In general, this cut may be cut, drilled, and shot while the previous pillar line is being finished, but may not be loaded until all the operations on the previous pillar line are completed.

ROOF SUPPORT: Due to equipment limitations, general practice allows the taking of this first cut prior to the placement of the turn posts.

VENTILATION: A face curtain is hung outby the breaker posts. Airflow is through the entry, sweeping the face, and then into the gob.

HAULAGE: The change-out point can be located at the first intersection.





Open Ending
Cut 1

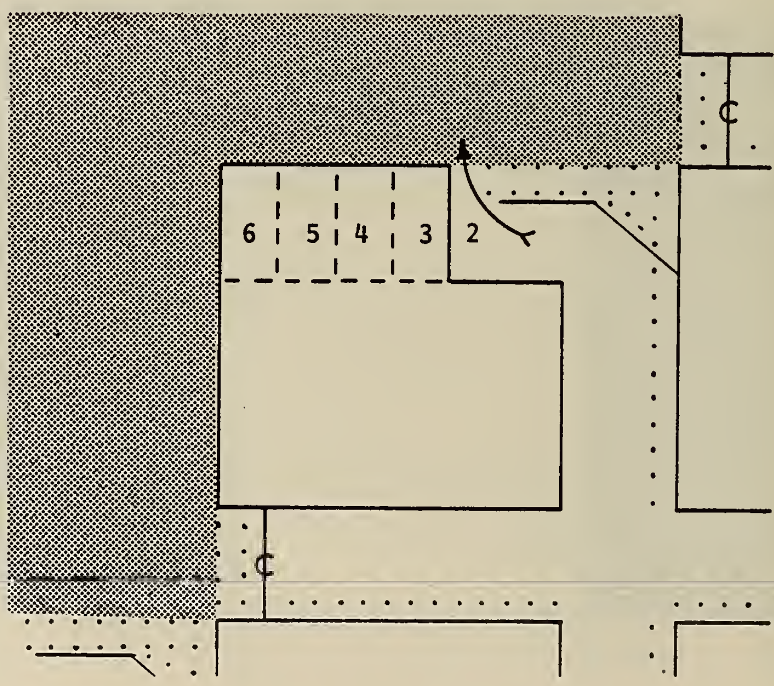
HO282021 | Figure 49

Cuts 2 through 6 remove the rear portion of the pillars.

ROOF SUPPORT: A row of turn posts is placed across the entry after Cut 1 is loaded. The breaker posts are kept within 7 feet of the face. Only the breaker posts for Cut 2 are shown below.

VENTILATION: A face curtain is hung on the turn posts and breaker posts. It will be kept within 10 feet of the face as the face is advanced.

HAULAGE: Same as Cut 1.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Open Ending
Cuts 2-6

HO282021

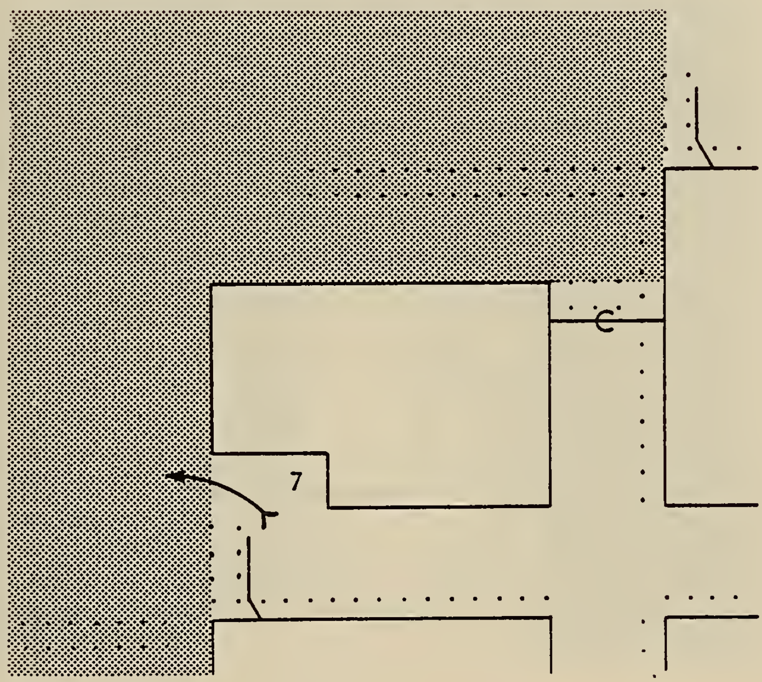
Figure 50

Cut 7 is the first cut in the second work area of each pillar in the pillar line.

ROOF SUPPORT: The entry to the first work area is timbered off with breaker posts.

VENTILATION: A check curtain is hung across the entry on the breaker posts just set. Airflow is through the crosscut, across the face, and into the gob.

HAULAGE: The change-out can still be located in the first intersection.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- -F- Fly Curtain
- Stopping
- =R= Regulator
- (A) Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Open Ending
Cut 7

HO282021

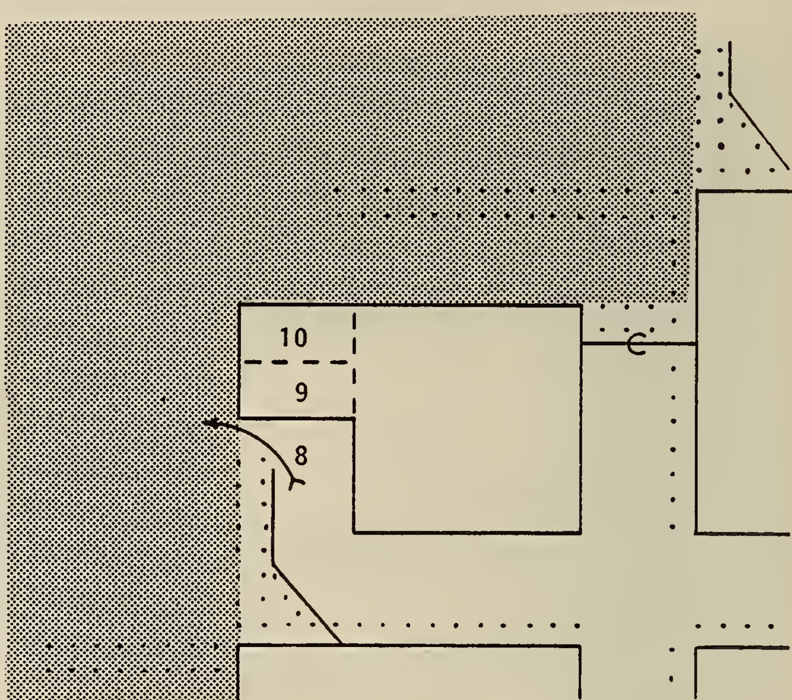
Figure 51

Cuts 8-10 complete the left side of the pillar.

ROOF SUPPORT: After Cut 7 has been loaded, breaker posts are set closer to the face and the roof is bolted. Turn posts are placed across the crosscut leading into the work area.

VENTILATION: The face curtain is extended into each cut after it has been loaded. Airflow is into the work area, across the face, and into the gob.

HAULAGE: Same as Cut 7.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Open Ending
Cuts 8-10

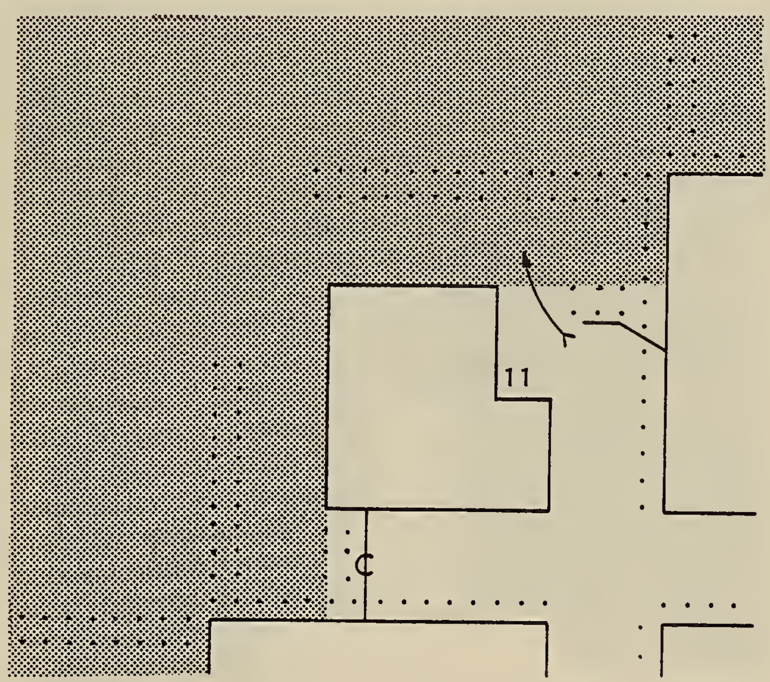
HO282021 | Figure 52

Cut 11 is the first cut in the third work area of each pillar in the pillar line.

ROOF SUPPORT: Breaker posts are set in the crosscut.

VENTILATION: A check curtain is hung across the crosscut on the breaker posts just set. The curtain in the active entry is moved to deflect air into the cut.

HAULAGE: The change-out is still located in the first intersection.



LEGEND

Intake Air	Cable Anchor Point
Return Air	Shuttle Car Path
Face Curtain	Discharge Point
Check Curtain	Roadway/Turn Posts
Fly Curtain	Breaker Posts
Stopping	Cribbing
Regulator	Gob

Open Ending
Cut 11

HO282021

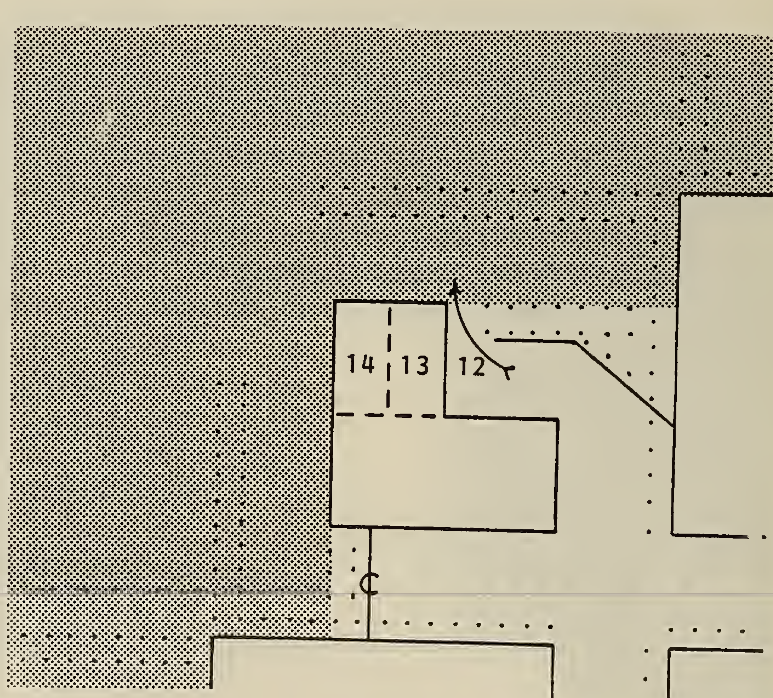
Figure 53

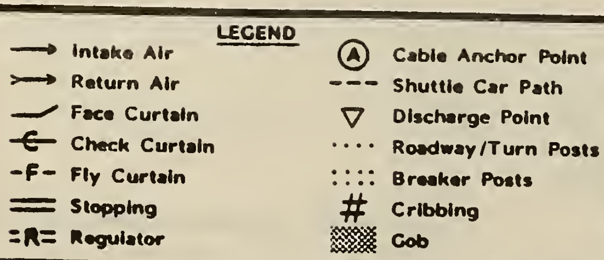
Cuts 12-14 complete the extraction of the third work area of the pillar.

ROOF SUPPORT: Breaker posts will be maintained within 7 feet of the face. Turn posts are placed across the entry, leading into the work area, after Cut 11.

VENTILATION: A face curtain is maintained within 10 feet of the face.

HAULAGE: Same as Cut 11.





Open Ending
Cuts 12-14

HO282021

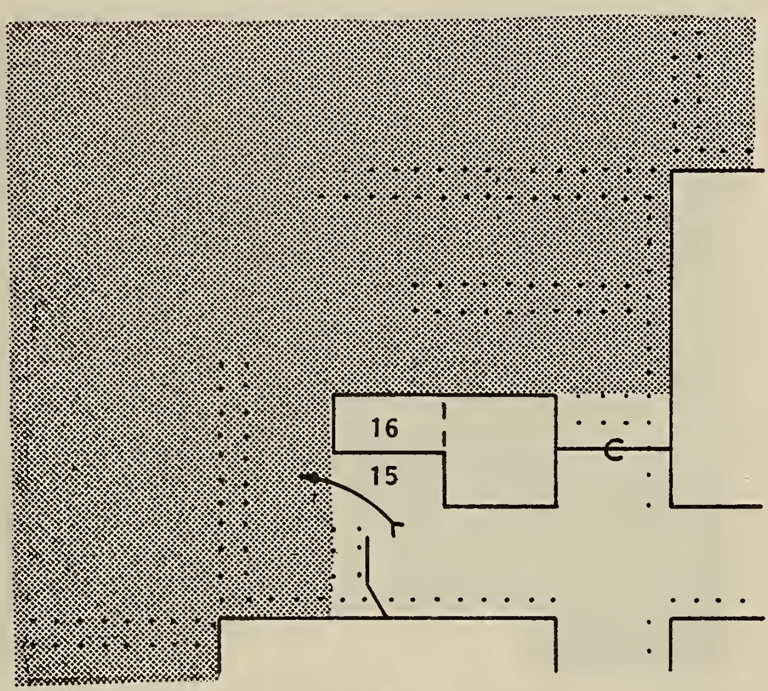
Figure 54

Cuts 15 and 16 reduce the pillar to a single stump.

ROOF SUPPORT: Breaker posts will be maintained within 7 feet of the face. Turn posts will be set across the crosscut leading into the work area after Cut 15 is loaded.

VENTILATION: A check curtain is hung across the entry. The curtain in the crosscut is moved to deflect air into the face and is maintained within 10 feet of the face.

HAULAGE: No change.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Open Ending
Cuts 15 and 16

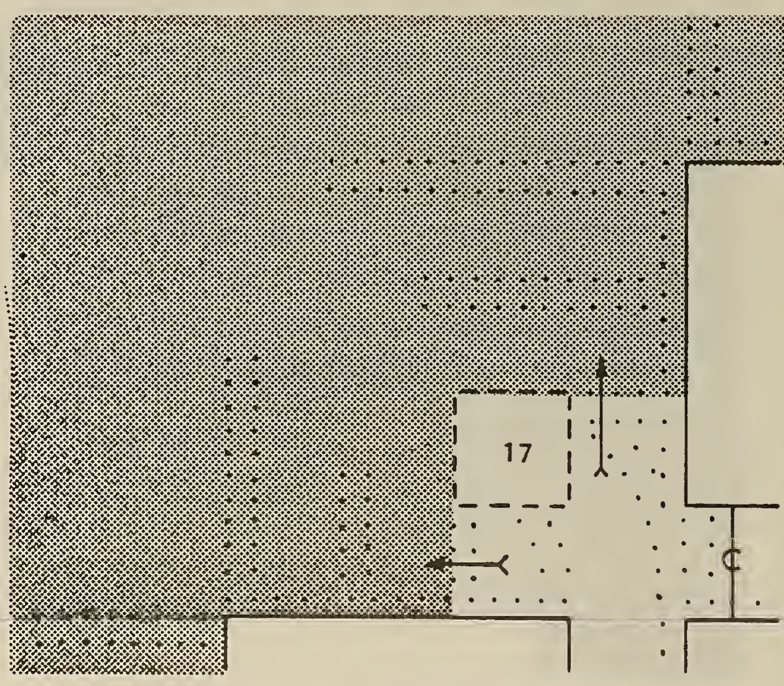
HO282021 | Figure 55

Cut 17 is the final cut--the pushout--in each of the pillars. Access through the entry as shown is generally easier from a logistic standpoint but may not be possible due to mining conditions.

ROOF SUPPORT: Breaker posts are set in the crosscut at the gob line. Breaker posts are also set across the crosscut at the intersection since it will not be used during the recovery of the pushout stump.

VENTILATION: All curtains inby the intersection are withdrawn. A check curtain is hung across the inactive crosscut outby the breaker posts.

HAULAGE: Haulage during removal of the pushout is limited to one entry. A 14-foot roadway is provided leading into the pushout stump. The change-out point is one crosscut outby the pillar.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Open Ending
Cut 17

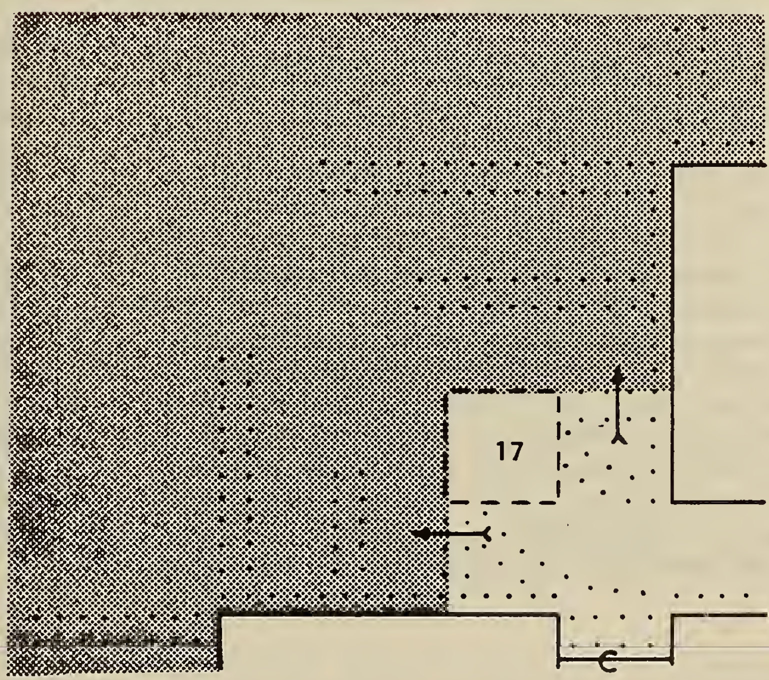
HO282021 | Figure 56

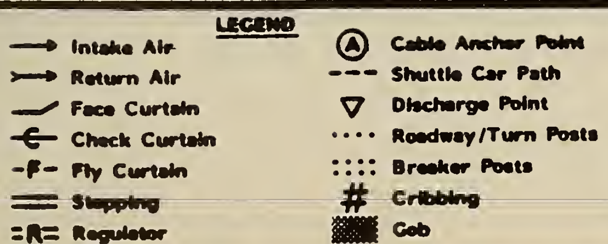
If mining conditions are such that access through the entry is not possible, access to the pushout can be obtained through the crosscut, as shown here.

ROOF SUPPORT: Breaker posts are set across the crosscut, outby Cut 12. Breaker posts are also set across the entry which will not be used to recover the pushout.

VENTILATION: All curtains inby the intersection are withdrawn. A check curtain is hung across the inactive entry outby the breaker posts.

HAULAGE: Haulage during removal of the pushout is limited to one entry outby the pushout. A 14-foot roadway is provided leading into the pushout stump. The change-out is one crosscut outby the pillar.





Open Ending
Alternate Cut 17

HO282021

Figure 57

Properties of the Process

Open ending has been used successfully by many mines in the past and is still successful in the mines using it. The process has a number of advantages. It is usually not limited by the size of the pillar. Working places are always next to the gob, and there is always solid support outby the working place.

Conditions of Usage

The size of the pillar is usually not a limiting condition for using open ending, although small pillars could probably be extracted more easily with split and fender. Under good conditions, the roof should be competent enough to span the pockets driven the length of the pillar yet brittle enough to permit breaking off beyond the breaker posts where the pressures would otherwise start bending the roof material. The roof should also give adequate warning of increasing pressures and should break along relatively predictable lines. The coal should not slough excessively since sloughing increases the span beyond safe limits. In addition, the coal should have enough strength to safely support the roof over working places and entries or crosscuts if properly timbered. The floor should also provide the necessary support. Open ending can be used under conditions less desirable than these, although some coal may be left in stumps near the end of the pockets.

Open ending is used only with conventional mining equipment. The process can be practiced with most methods and conditions of mining although it may not be the most desirable economically.

Areas of Usage

Open ending is most commonly practiced in MSHA District 7. The process is used fairly commonly in Tennessee and Alabama, in the Sewanee, Blue Creek, and Pratt coal seams. Each seam has a hard shale (slate) or sandstone roof and a clay or shale floor, generally in faulted areas where the seam thickness varies. Other mines utilizing open ending are scattered in seams throughout MSHA Districts 4, 5, and 7, near the eastern edge of the coalfields in southern West Virginia, western Virginia, and southeastern Kentucky, respectively, where the strata are generally folded and faulted. The coal seams in these areas vary in thickness, and conventional mining is advantageous and usually preferred. More detailed information concerning specific areas of usage can be found in the appendix.

Chapter 5. BASIC RETREAT METHODS OF PANEL DEVELOPMENT AND EXTRACTION

In chapter 4, the basic processes for extracting individual pillars were presented. This chapter will present a similar discussion related to the three basic retreat methods for the development and full pillar extraction of production panels. Prior to reading this chapter, the mine engineer should review the information provided in chapter 2, Summary and Comparison of Mining Techniques. Following this review, the selection for careful study of one or two of the methods presented in detail in this chapter should be possible.

Discussions include the conditions under which each method is effective and the areas where it is used. The ventilation and haulage requirements for each method will also be presented in detail.

The three basic methods that will be presented are as follows:

1. Full extraction on retreat.
2. Rooms driven and extracted on retreat.
3. Rooms driven and extracted on both advance and retreat.

The "rooms only" method discussed in chapter 2 does not involve retreat mining and will not be discussed in detail in this manual.

Full Panel Extracted on Retreat

The full panel extracted on retreat method involves (1) the development of a production panel consisting of five or more entries and (2) the subsequent extraction of the resulting pillars while withdrawing from the panel. The overall sequence of panel development and extraction is as follows:

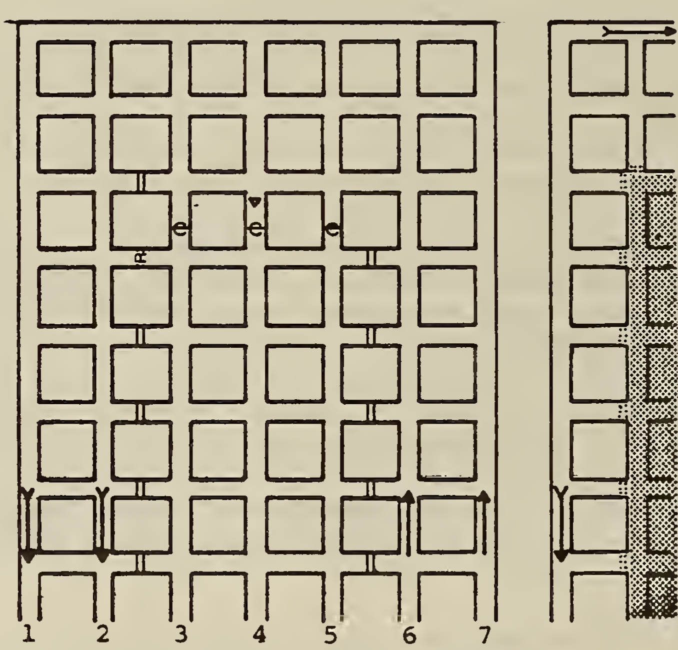
1. Panel Development. The entries are developed to the limit of the panel. As development occurs, haulage must be advanced and permanent stoppings must be maintained up to and including the third crosscut outby the working face.

2. Bleeder Connection. When the end of the panel is reached, provisions must be made to bleed gases from the area prior to second mining.

3. Pillar Extraction. As equipment is withdrawn from the panel, the pillars are extracted in a manner that results in caving of the main roof.

These operations are performed sequentially and are illustrated in figures 58 through 72. The panel shown involves an interconnected bleeder system with a standing panel bleeder entry. For discussion of other panel bleeder designs see the material presented in chapter 6, Mine Planning and Retreat Mining.

The example shown in this and subsequent drawings illustrates a seven-entry panel developed during the advance. It will be expanded to eight entries during retreat by mining through the barrier pillar between the active panel and the previously mine adjacent panel to the right. The particular method for extraction of the barrier block is not part of the Full Extraction on Retreat method. It is, however, illustrative of a technique that can be incorporated with this and other panel extraction methods. Caving is assumed to be tight enough to require leaving a row of bleeder blocks in each panel during retreat mining. The figure below shows the panel as development is completed. The panel contains two intakes, two returns, and three neutral intake entries. Haulage is located in entry 4. Throughout this series of illustrations, a regulator will be shown in the first crosscut outby the discharge point. This is merely a stopping with a block or two missing in order to maintain airflow from the haulage entry directly into the panel returns.



LEGEND

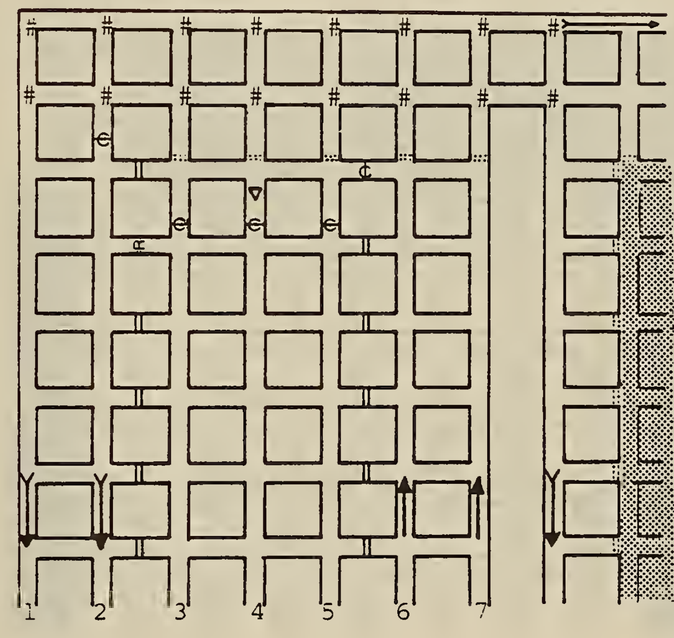
- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Panel Development

HO282021

Figure 58

Once panel development is completed, the active panel is connected to the bleeder system. The figure below shows the last two crosscuts of the panel being utilized for bleeder entries. A minimum of two entries are used in the bleeder system to keep it operational in case a roof fall or other obstruction limits the airflow in one of the entries. Breaker posts are set across the entries inby the third crosscut to prevent falls from riding back into the bleeder entries. The bleeder entries are heavily cribbed to provide protection against closure by roof falls.



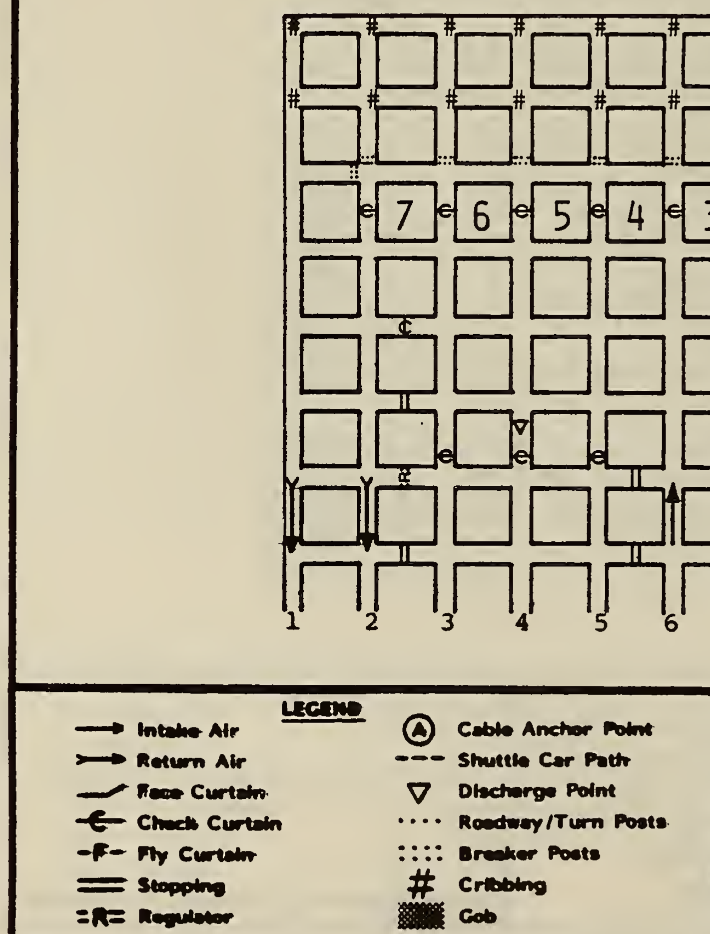
LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Bleeder Connection

HO282021 | Figure 59

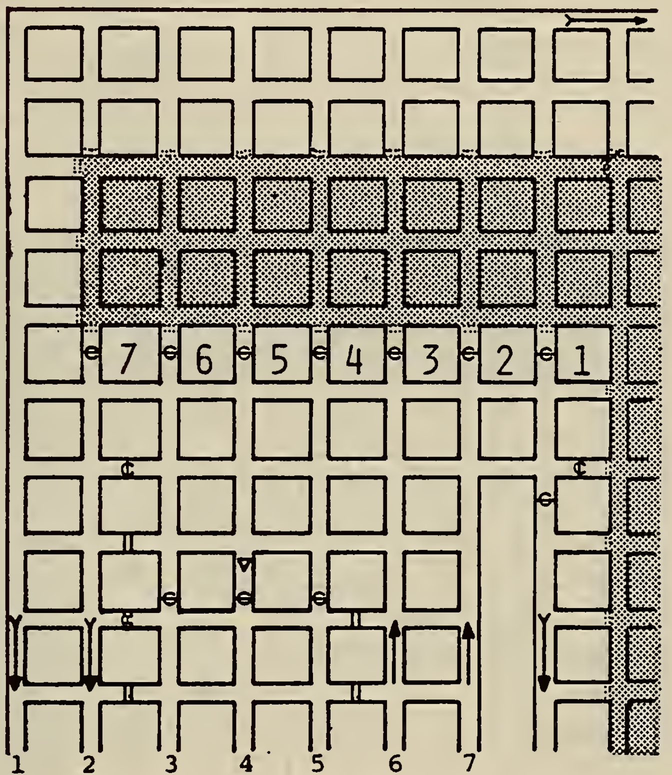
Before pillar extraction commences in the panel, at least three crosscuts must be driven through the barrier pillar to provide access to the bleeder entry of the previous panel. For each succeeding row of pillars, only one crosscut will be mined through the barrier pillar. There should be one open crosscut outby the pillar line to provide a second escapeway from the pillar adjacent to the gob. Pillar extraction can commence after crosscuts are completed through the barrier pillar. Pillars are extracted from the gob side towards the solid side of the panel. The pillar line shown below contains seven pillars: five from the active panel, one from the barrier pillar, and one from the previous panel. The pillar adjacent to the return is left standing to ensure proper ventilation of the gob. It will become pillar number 1 during the extraction of the next panel. The ventilation and haulage positions shown are the positions taken as the panel is prepared for extraction of the first pillar row.



Full Extraction on Retreat
First Pillar Row

HO282021 | Figure 60

After the first rows of pillars have been extracted, the procedures shown in the following drawings will be repeated. The figure below shows a typical pillar line in the panel displaying the order in which the pillars should be extracted.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Typical Pillar Row

HO282021

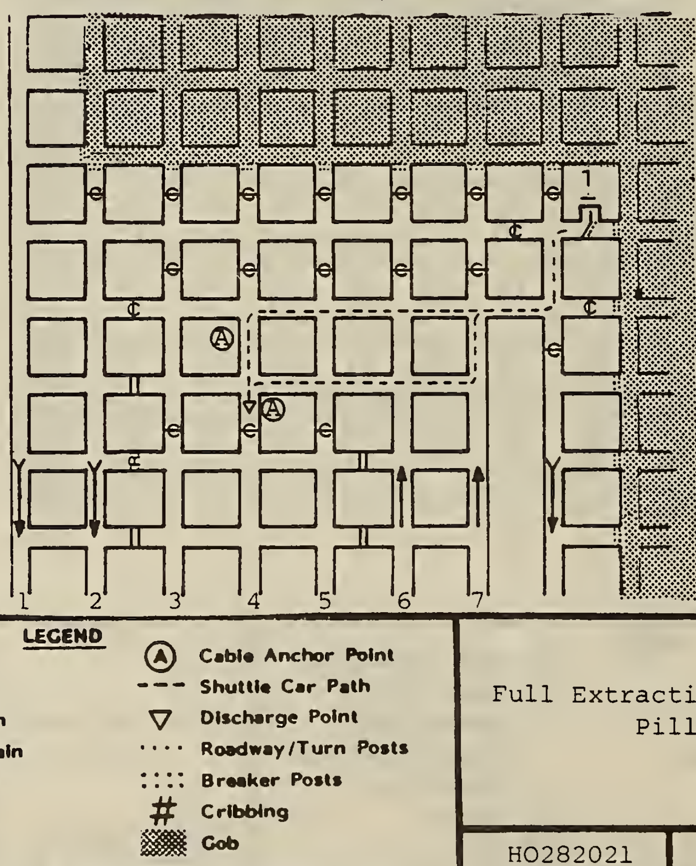
Figure 61

Pillar 1 is the pillar left from the previous panel to protect the bleeder entry. This pillar may be inaccessible because of deterioration of conditions since the previous panel was developed.

ROOF SUPPORT: Breaker posts are set across all openings to the gob.

VENTILATION: Check curtains are hung across all openings in the pillar line to the gob. A check curtain is loosely hung in the first open crosscut to force the bulk of the ventilation across the active face.

HAULAGE: Two independent haulage paths are shown with the change-out located at the second intersection outby the pillar. Trailing cable anchor points are optimally located for the paths shown. Use of the long-standing entry from the previous panel may be limited if significant deterioration has taken place. This would require an alternative haulage path.



Full Extraction on Retreat Pillar 1

HO282021

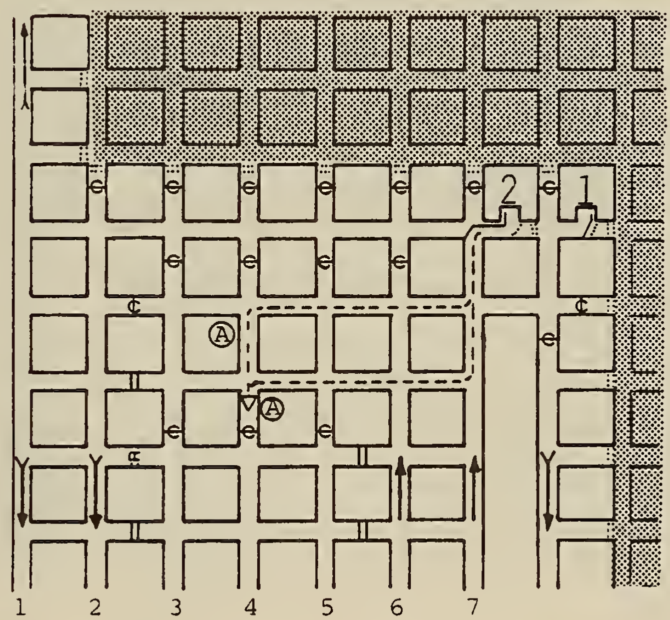
Figure 62

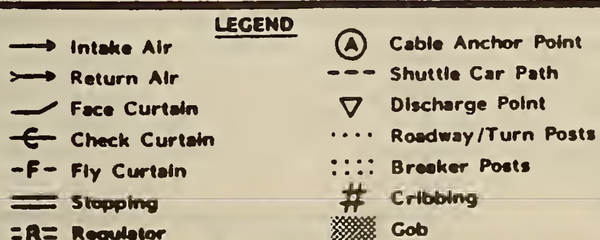
The second pillar in the line can be extracted in a manner similar to the first pillar using most of the pillar extraction processes. Using the split and fender process, however, it will be necessary to initiate double split face ventilation as shown below and as explained in the detailed discussion in Chapter 4.

ROOF SUPPORT: Breaker posts are set at all openings to the gob. Turn posts are set leading into all splits.

VENTILATION: The curtain placement shown results in return air from the second pillar venting into the return. The return air from the first pillar will sweep the gob and then flow into the bleeder. The alternative ventilation plan shown in the next figure may have to be used under some mining conditions.

HAULAGE: Haulage paths and anchor points are optimum as shown. Obstructions may necessitate the use of other paths.

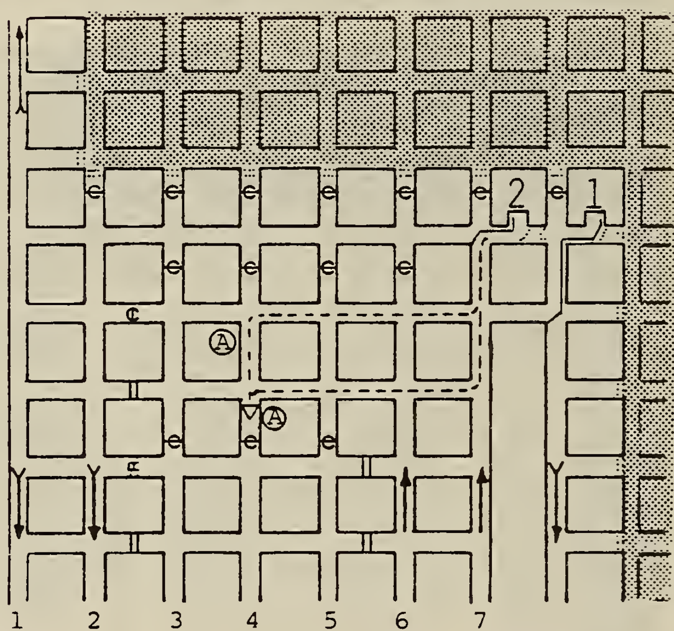


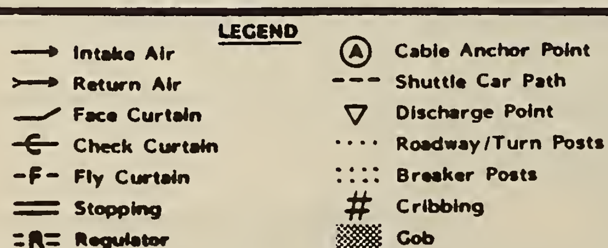


Full Extraction on Retreat
Pillar 2

HO282021 | Figure 63

Under conditions where the gob is very compact or falls very close to the pillar line and significant airflow through the gob is not possible, use of a plan such as that shown below would be necessary in order to initiate double-split face ventilation. In this plan, the curtain arrangement of the first pillar is such that return air from it vents directly into the old return from the previous panel. A plan such as this would have to be used throughout this pillar extraction sequence; however, it will be shown only for the number 1 and 2 pillars. Its adaptation to the rest of the line is not difficult.





Full Extraction on Retreat
Pillar 2 (Alternative)

H0282021

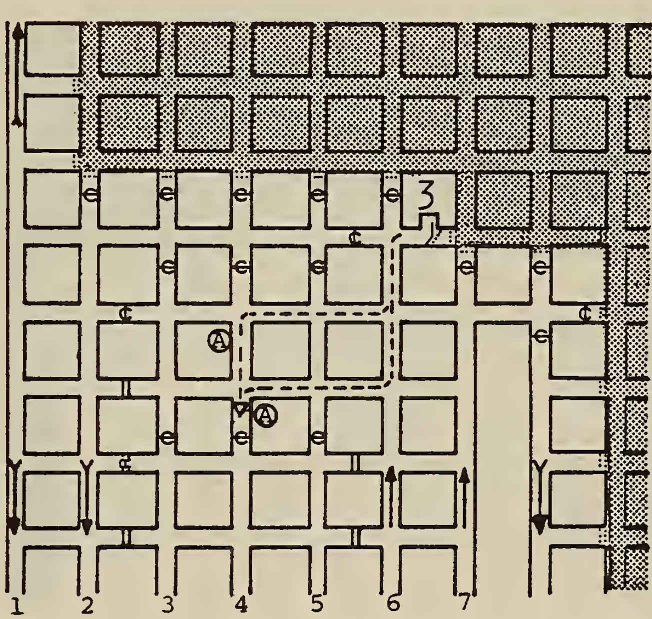
Figure 64

Pillar 3 is shown below. Pillars 1 and 2 are shown to be mined out and part of the gob.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: A check curtain is loosely hung in the last crosscut to direct the airflow by the working place and into the gob. This curtain is best located at pillar 4 where preparations are taking place for the alternate cuts in this sequence.

HAULAGE: Two independent haulage paths are shown outby the pillar being extracted.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Pillar 3

HO282021

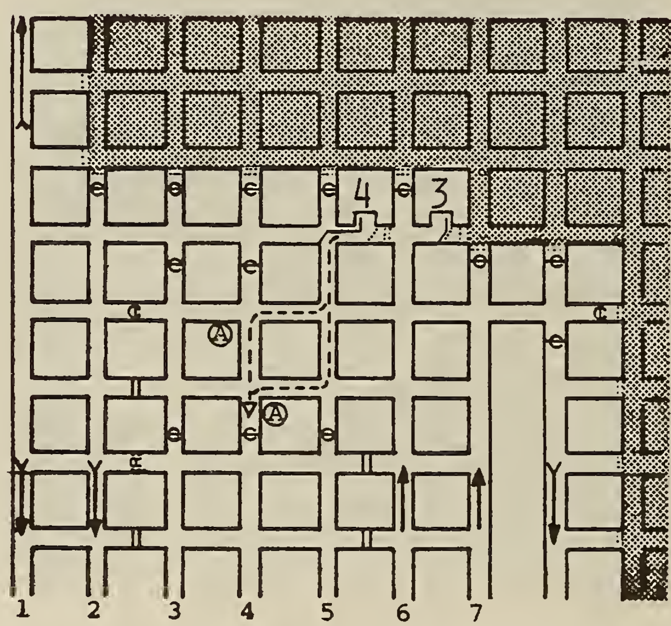
Figure 65

Pillars 3 and 4 are shown below. Pillars 1 and 2 are shown to be mined out and part of the gob.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: As the split is initiated in pillar 4, the check curtain that was in the crosscut between entries 5 and 6 is converted to a face curtain. This allows double split face ventilation once more.

HAULAGE: Independent haulage paths with the change-out in the second open crosscut are shown. Shuttle car anchor points have not yet been moved.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Pillar 4

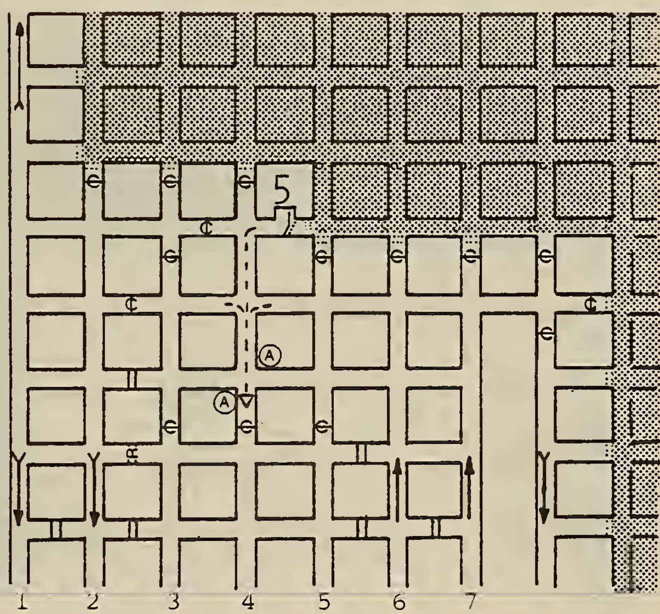
HO282021	Figure 66

Pillar 5 is shown below. Pillars 1 through 4 are shown to be mined out and part of the gob.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: A check curtain is once again hung in the open crosscut at the next pillar in the sequence.

HAULAGE: To prevent interference from trailing cables in the entries during mining of the split in pillar 6, the anchor points are relocated. A dependent haulage path is shown due to the short haul distance.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Pillar 5

HO282021

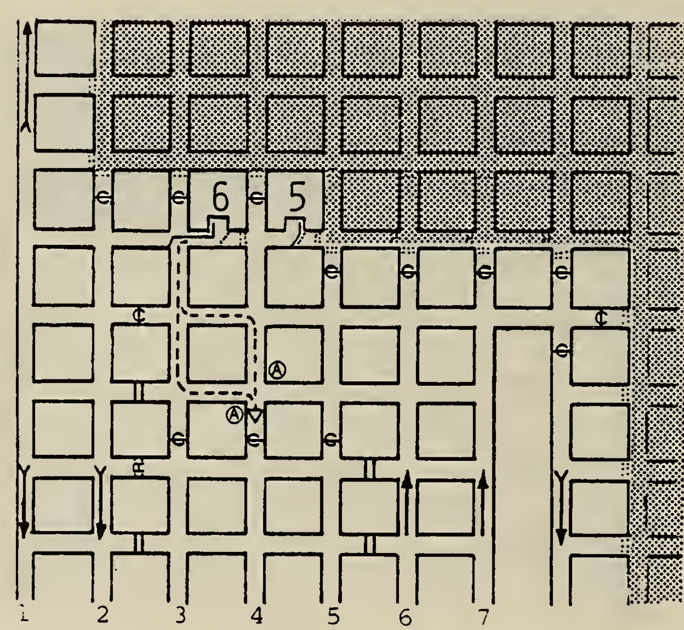
Figure 67

Pillars 5 and 6 are extracted in a manner similar to that used for pillars 3 and 4. Pillars 1 through 4 are shown to be mined out and part of the gob.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: The curtain placement results in double split face ventilation similar to the ventilation patterns used during the extraction of pillar pairs 1-2 and 3-4.

HAULAGE: Independent haulage paths are shown. The anchor point locations used for the extraction of pillar 5 will allow these independent paths.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Pillar 6

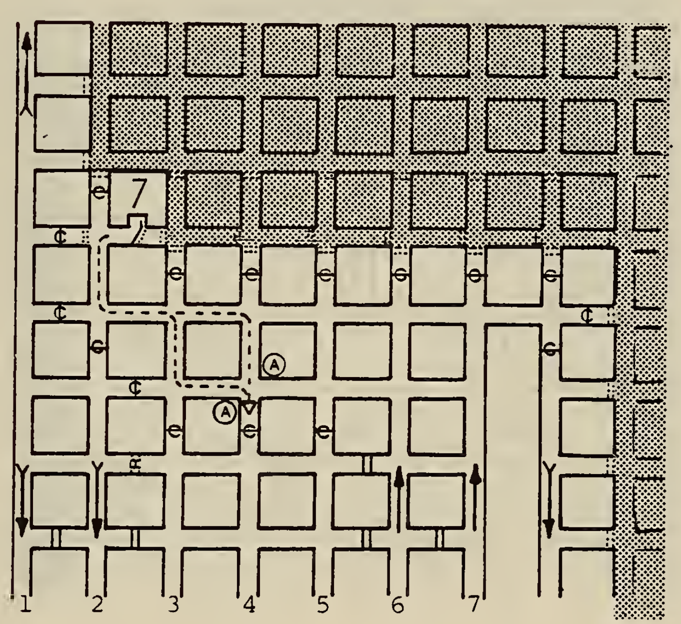
HO282021 | Figure 68

Pillar 7 is the final pillar in the pillar line. Pillars 1 through 6 are shown to be mined out and part of the gob. During the extraction of pillar 7, or any other lone pillar, sequencing the cuts with the next pillar line or between three pillars instead of two will be necessary if the split and fender process is used. Alternatively, the mining of pillar 1 might be sequenced with cuts through the barrier block.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: Return air is restricted to only one entry (entry 1) while extracting this pillar. Single split ventilation is shown.

HAULAGE: Independent haulage paths are shown with the change-out in the second crosscut outby. The change-out can be located in the first crosscut outby if the stopping in the second crosscut is removed.



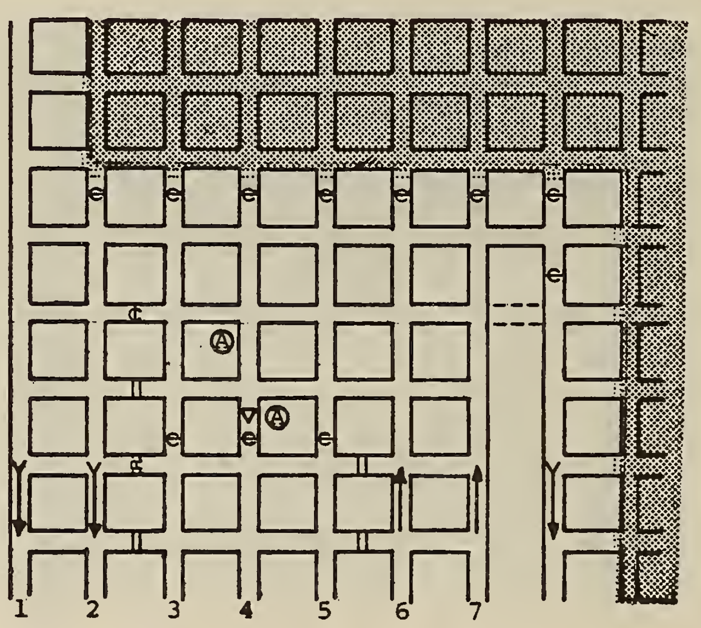
LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Pillar 7

HO282021 Figure 69

Below is shown the section configuration following the belt move. The discharge point is moved one crosscut back. One row of stoppings is removed on both the intake and return sides. The regulator in the return stopping is moved one crosscut outby its previous location. Check curtains are moved to the locations indicated. The trailing cable anchor points for the shuttle cars are relocated. The next crosscut in the barrier pillar should be completed before the removal of the next pillar line is begun. The mining of this crosscut (shown below with dashed lines) might be sequenced with the mining of a pillar split in order to minimize roof bolting delays.



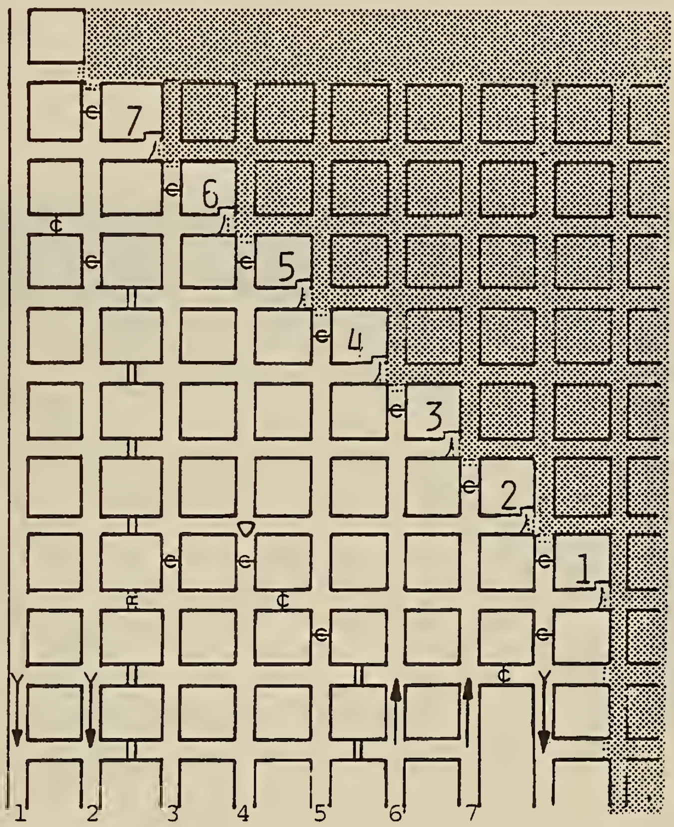
LEGEND

→	Intake Air	Ⓐ	Cable Anchor Point
≻→	Return Air	---	Shuttle Car Path
—	Face Curtain	▽	Discharge Point
—€—	Check Curtain	....	Roadway/Turn Posts
-F-	Fly Curtain	::::	Breaker Posts
==	Stopping	#	Cribbing
=R=	Regulator		Gob

Full Extraction on Retreat
Belt Move

HO282021 | Figure 70

When mining with conventional equipment, an angled pillar line such as that shown below is desirable. Either the open-end or split-and-fender pillar extraction methods can be used. With conventional mining, cuts are made in all pillars at the same time. Change-out points are kept as close to the pillar as possible. Air is regulated by closing curtains at working places. The roof support requirements for this method were described in the previous chapter.



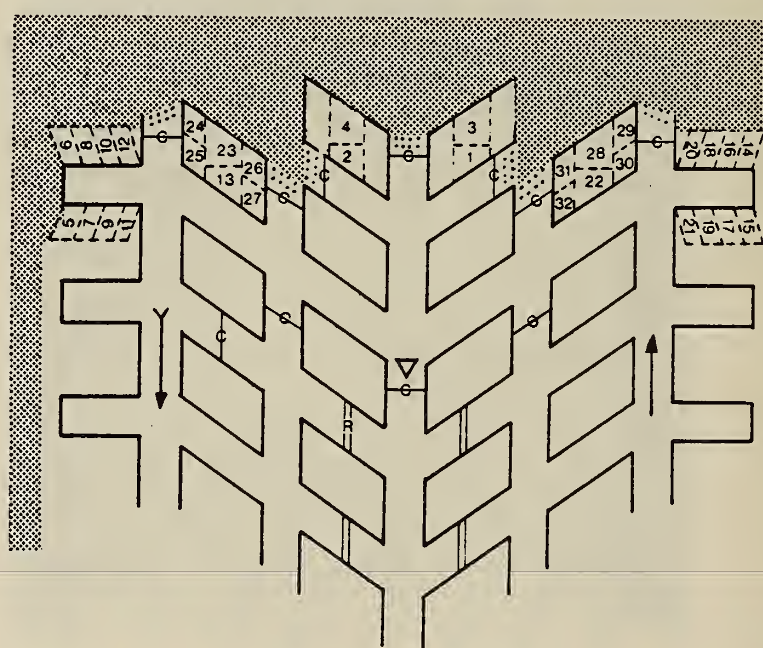
LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Conventional Mining

HO282021 Figure 71

Continuous haulage systems are finding increased acceptance in the industry. While some systems can cut rectangular pillars, others are limited to a pattern similar to that shown below. In both cases, they have had only limited success on sections where retreat mining is practiced. The difficulties include the irregular pillar line which creates pressure points, difficulty in ventilation, and the extraction of the center pillars. Several pillar extraction sequences have been utilized. The sequence described below requires full bolting in the splits. The unmined area shown in the center pillars designates coal that generally cannot be extracted because of high risk of roof falls.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Full Extraction on Retreat
Continuous Haulage

HO282021 | Figure 72

Rooms Driven and Extracted on Retreat

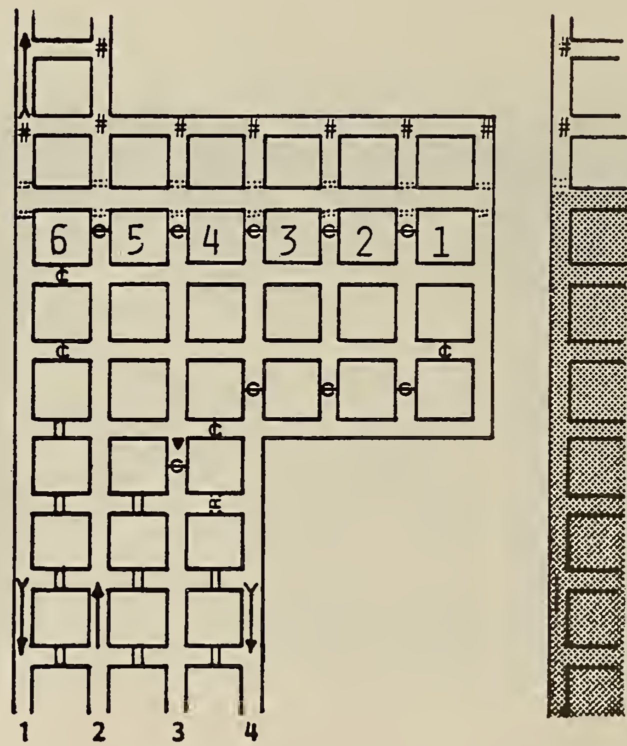
The rooms-driven-and-extracted-on-retreat method involves the development of a production panel of three to five entries to the designated panel length. (Four entries are shown in the example.) The panel is then connected to the bleeder system. Rooms are developed on one side as the equipment is withdrawn. The resulting pillars and the previously developed chain pillars are extracted. Normally, the production rooms are driven on narrower centers than shown in the example that follows because they will stand for only a short period of time. However, for simplicity, the same dimensions are used for both the chain and production pillars. Figures 73 through 80 describe the method in detail.

This figure shows the overall pillar extraction sequence. Also shown is the posting and cribbing for bleeder protection at the top of the panel.

ROOF SUPPORT: The bleeder connection and the last crosscut are timbered and cribbed to prevent closure.

VENTILATION: Shown on individual pillar extraction diagrams.

HAULAGE: Shown on individual pillar extraction diagrams.



LEGEND

Intake Air	Cable Anchor Point
Return Air	Shuttle Car Path
Face Curtain	Discharge Point
Check Curtain	Roadway/Turn Posts
Fly Curtain	Breaker Posts
Stopping	Cribbing
Regulator	Gob

Rooms Extracted on Retreat
Overall Pillar Sequence

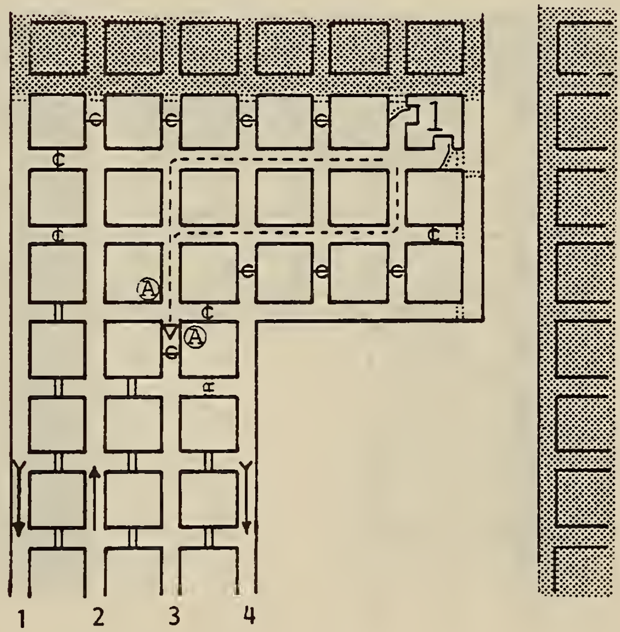
HO282021 Figure 73

The first pillar in the extraction sequence is shown below. The extraction sequence is illustrated for pocket-and-wing extraction. The sequence for split-and-fender extraction shown previously in the "Full Extraction on Retreat" section could be easily applied in this panel sequence.

ROOF SUPPORT: Breaker posts are place at all openings to the gob.

VENTILATION: Air is regulated at the faces. Return air from the working faces is drawn partially across the mined out area and partially through the last open crosscut to the panel returns in entries 1 and 4.

HAULAGE: Independent haulage paths are possible with the change-out in the first outby intersection.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Retreat
Pillar 1

HO282021

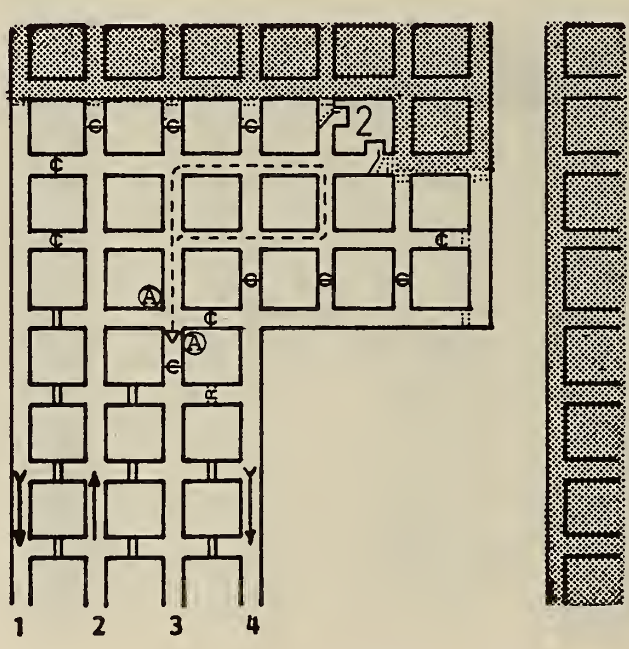
Figure 74

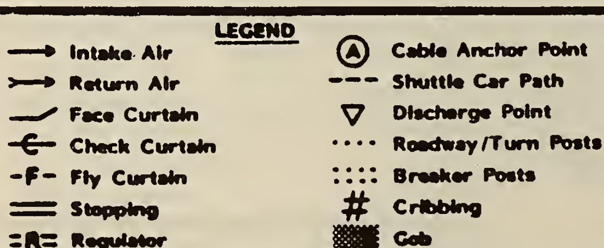
The second pillar in the extraction sequence is shown.

ROOF SUPPORT: Breaker posts are placed at all openings to the gob.

VENTILATION: Return air from the working faces is drawn partially through the gob and partially through the panel returns in entries 1 and 4.

HAULAGE: Independent haulage paths are possible with the change-out in the first intersection.





Rooms Extracted on Retreat
Pillar 2

HO282021

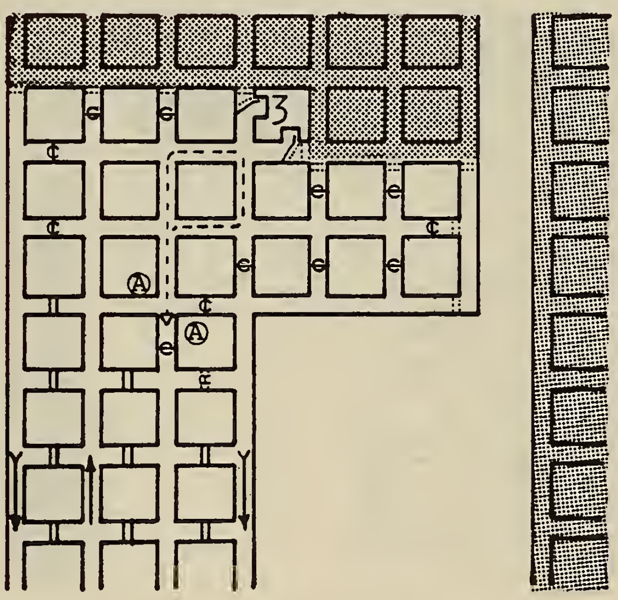
Figure 75

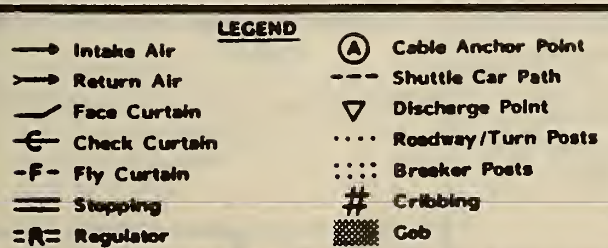
The third pillar in the pillar extraction sequence is shown.

ROOF SUPPORT: Breaker posts are placed across all openings to the gob.

VENTILATION: Return air paths are similar to those shown for the extraction of pillars 1 and 2.

HAULAGE: Independent haulage paths are possible.





Rooms Extracted on Retreat
Pillar 3

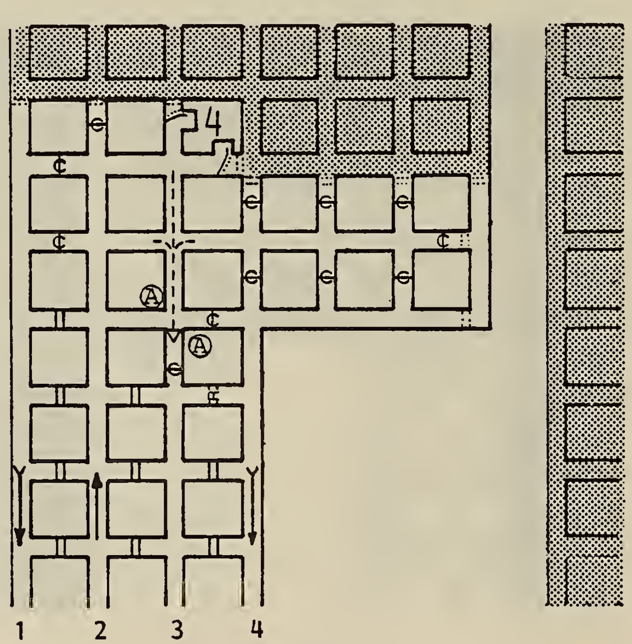
HO282021 | Figure 76

The fourth pillar in the extraction sequence is shown.

ROOF SUPPORT: Breaker posts are placed across all openings to the gob.

VENTILATION: Return air from the working faces continues to be drawn partially through the mine gob, into the bleeder, and partially into panel returns in entries 1 and 4.

HAULAGE: Independent haulage paths are not possible.



LEGEND

Intake Air	Cable Anchor Point
Return Air	Shuttle Car Path
Face Curtain	Discharge Point
Check Curtain	Roadway/Turn Posts
Fly Curtain	Breaker Posts
Stopping	Cribbing
Regulator	Gob

Rooms Extracted on Retreat Pillar 4

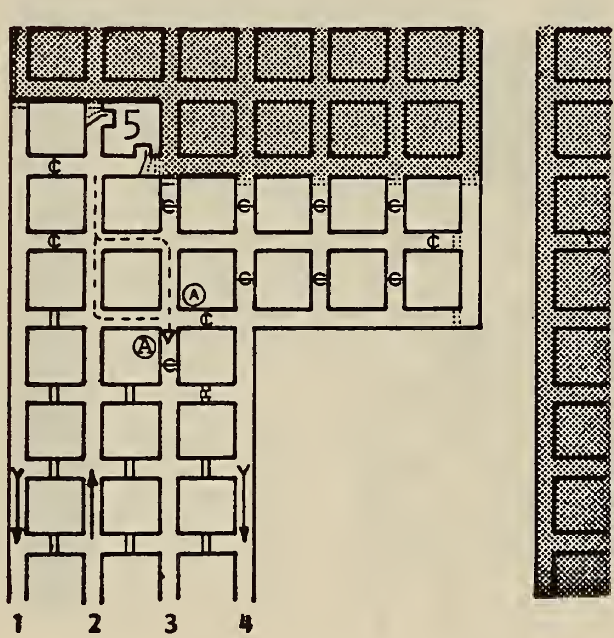
HO282021 Figure 77

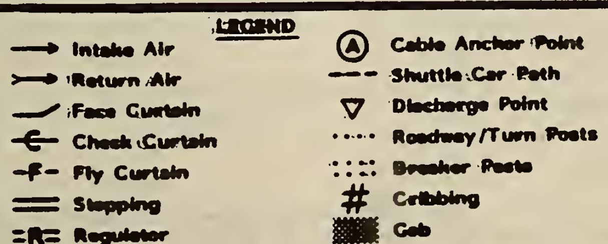
The fifth pillar in the extraction sequence is shown.

ROOF SUPPORT: Breaker posts are placed across all openings to the gob.

VENTILATION: Return air from the working faces continues to be drawn partially through the gob, into the bleeder, and partially into panel returns in entries 1 and 4. The inby stopping between entries 1 and 2 is removed and replaced with a check curtain in preparation for mining pillar 6.

HAULAGE: Independent haulage paths are possible. The shuttle car trailing cable anchor points are relocated to extract the last two pillars in the pillar line.





Rooms Extracted on Retreat
Pillar 5

HO282021

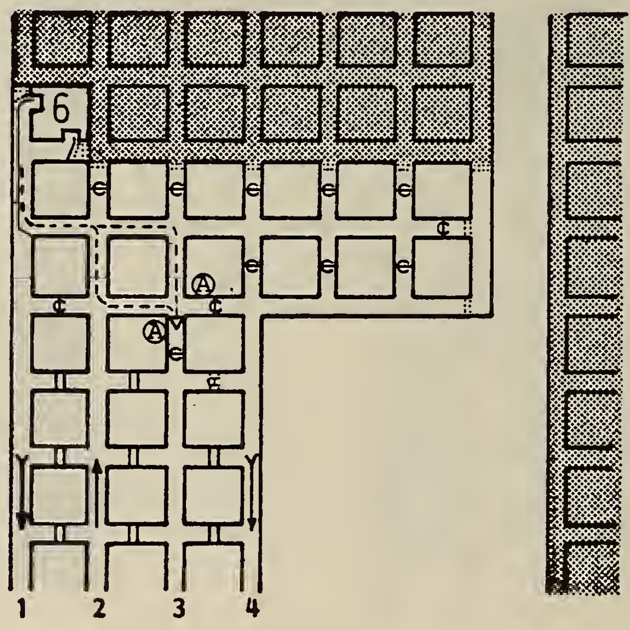
Figure 78

The sixth pillar in the extraction sequence is shown.

ROOF SUPPORT: Breaker posts are placed across all openings to the gob.

VENTILATION: Return air from the working faces continues to be drawn partially through the gob, into the bleeder, and partially into panel returns in entries 1 and 4.

HAULAGE: Independent haulage paths are possible with the change-out located at the intersections of the second crosscut.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Retreat
Pillar 6

HO282021

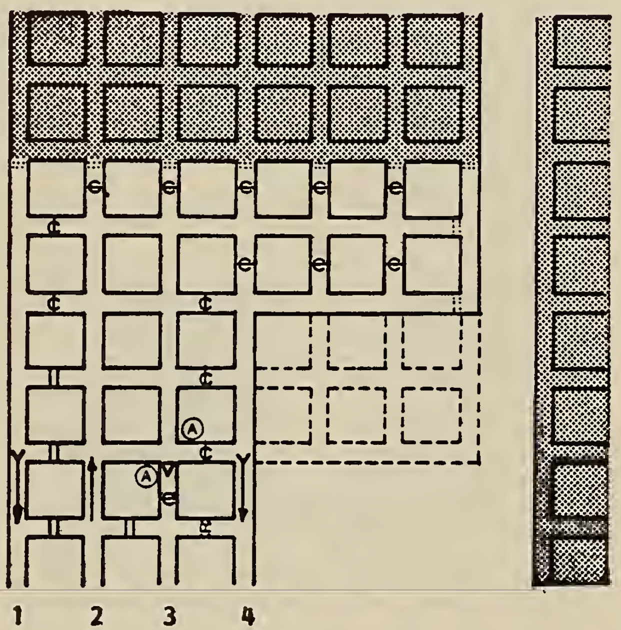
Figure 79

The panel extraction sequence has now been completed and the panel is prepared for the development of the next set of production rooms.

ROOF SUPPORT: Standard advance support plan.

VENTILATION: For this system of mining, a double split of air is used to ventilate the section.

HAULAGE: Standard development plan.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

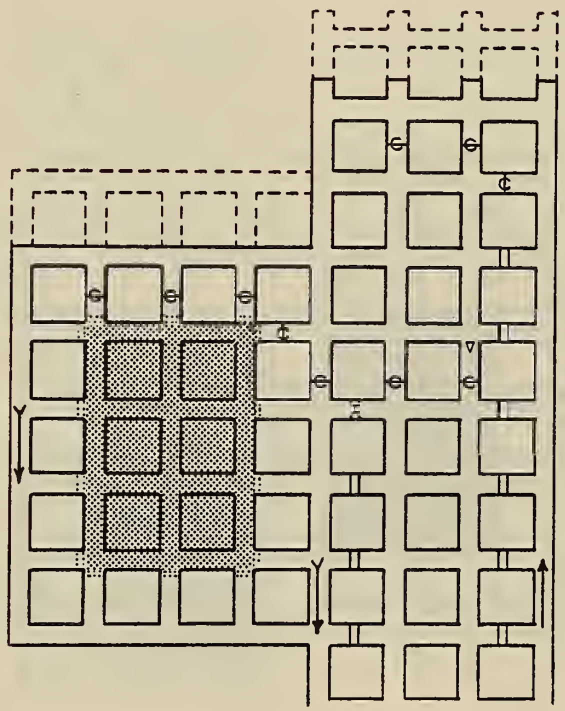
Full Panel Extracted on Retreat
Panel Completion

HO282021 | Figure 80

Rooms Driven and Extracted on Both Advance and Retreat

This method involves the development of production rooms on the return entry side as the panel is developed. These production pillars are extracted as the panel is developed. The completed panel is connected to the bleeder system. Production rooms are then developed on the intake side, and the production and chain pillars are recovered as the equipment is withdrawn. The system, illustrated in figures 81 through 93, uses the same pillar dimensions for both production and chain pillars. The use of smaller production pillars is more common. The particular method for connecting the bleeder, the retention of the barrier block, and the use of standing pillars in the bleeder entry are illustrative and not always required to perform the method being discussed.

In the "Rooms Extracted on Advance and on Retreat" method, pillar extraction is initiated during panel development. Rooms will be developed on the return side during panel development and the production pillars on the return side will be extracted. In the figure shown below, the neck of the panel has been developed and rooms driven on the return side. The first row of production pillars has been left to aid in ventilation, and pillars have been extracted on subsequent pillar rows as the panel is developed. A row of pillars has also been left on the perimeter of the panel for ventilation. Roof support, ventilation, and haulage characteristics will be shown in the following figures.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Advance and Retreat Panel Initiation

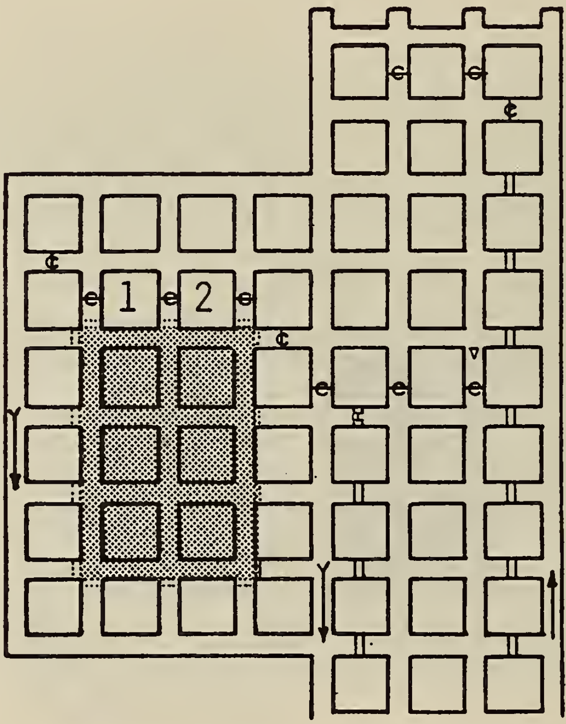
HO282021 | Figure 81

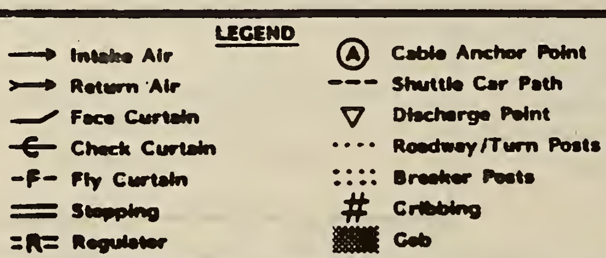
This figure shows the pillar extraction sequence for pillars while on panel development.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: Shown on individual pillar extraction diagrams.

HAULAGE: Shown on individual panel extraction diagrams.





Rooms Extracted on Advance and Retreat Pillar Extraction Sequence

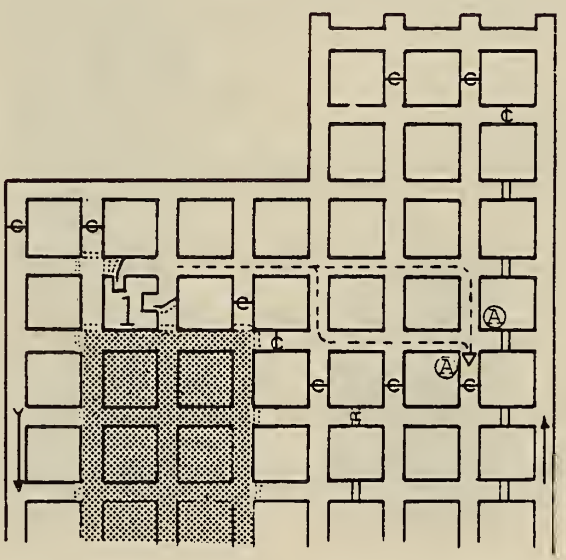
HO282021 Figure 82

The extraction of the first developmental production pillar is shown.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: In this extraction sequence, air is split at the pillar and flows over the mined out area and down the panel return.

HAULAGE: Independent haulage paths are used.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Advance and Retreat
First Pillar on Advance

HO282021

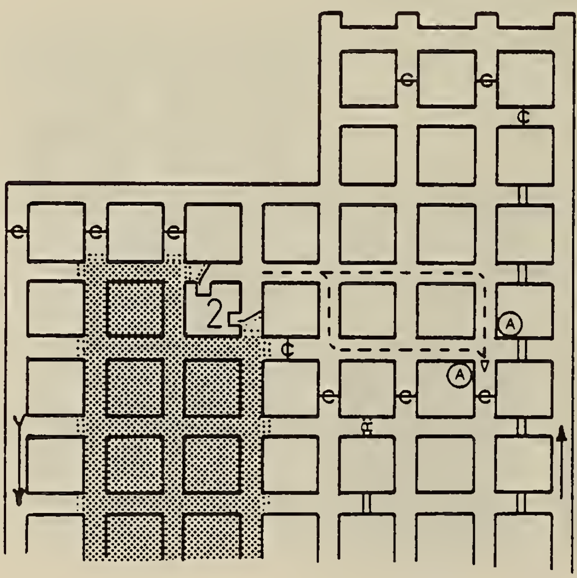
Figure 83

When extraction of the second pillar in the development extraction sequence is initiated, only minor changes are necessary.

ROOF SUPPORT: Breaker posts are placed across all openings to the gob.

VENTILATION: Air is split at the pillar and flows through the mined out area and down the panel return.

HAULAGE: Independent haulage paths are used.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Advance and Retreat
Second Pillar on Advance

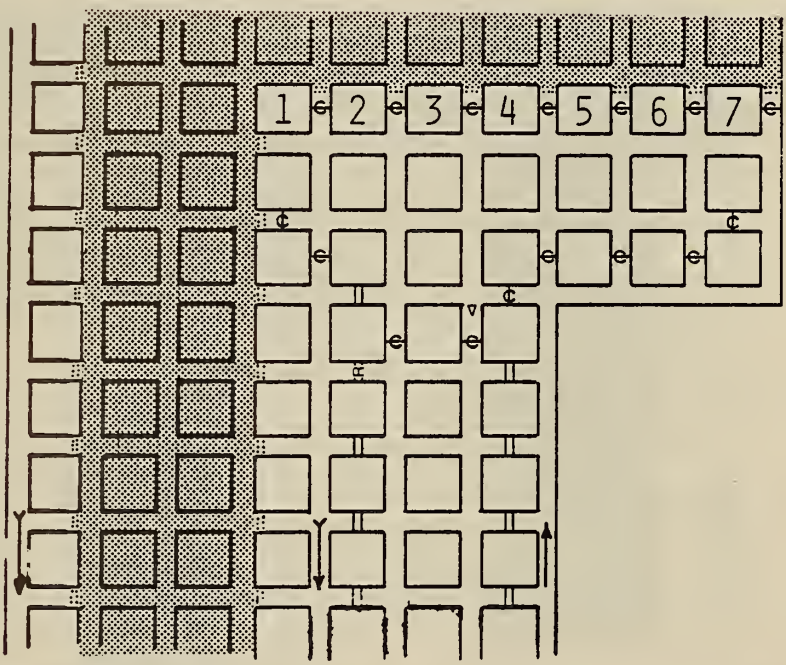
HO282021 | Figure 84

At the end of the panel a bleeder is established. The first panel pillar in each row is the pillar adjacent to the developmental production pillars, which are now gob. (Once again, the pillar line is mined from gob to solid.)

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: Shown on individual pillar extraction diagrams.

HAULAGE: Shown on individual pillar extraction diagrams.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- -F- Fly Curtain
- Stopping
- -R- Regulator
- (A) Cable Anchor Point
- Shuttle Car Path
- ▽ Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- # Cribbing
- Gob

Rooms Extracted on Advance and Retreat
Pillar Extraction Sequence

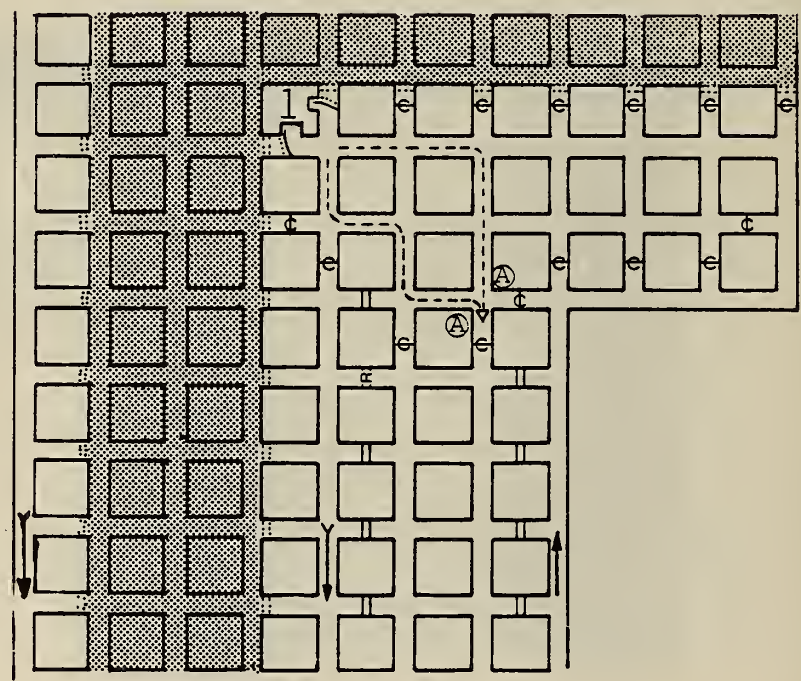
HO282021 | Figure 85

The extraction of the first pillar on retreat is shown.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: Air is split at the pillar and regulated with the face curtain.

HAULAGE: Independent haulage paths are used.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- -F- Fly Curtain
- Stopping
- :R: Regulator
- Ⓐ Cable Anchor Point
- --- Shuttle Car Path
- ▽ Discharge Point
- .... Roadway/Turn Posts
- :::: Breaker Posts
- # Cribbing
- Gob

Rooms Extracted on Advance and Retreat
First Pillar on Retreat

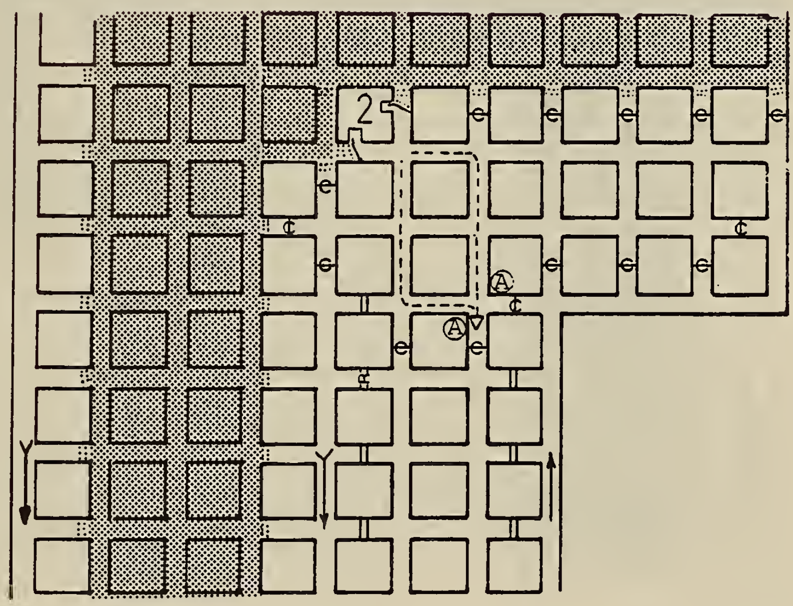
HO282021 Figure 86

The extraction of the second pillar on retreat is shown below.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: No change.

HAULAGE: Independent haulage paths are still maintained.



LEGEND

Intake Air	Cable Anchor Point
Return Air	Shuttle Car Path
Face Curtain	Discharge Point
Check Curtain	Roadway/Turn Posts
Fly Curtain	Breaker Posts
Stopping	Cribbing
Regulator	Gob

Rooms Extracted on Advance and Retreat
Second Pillar on Retreat

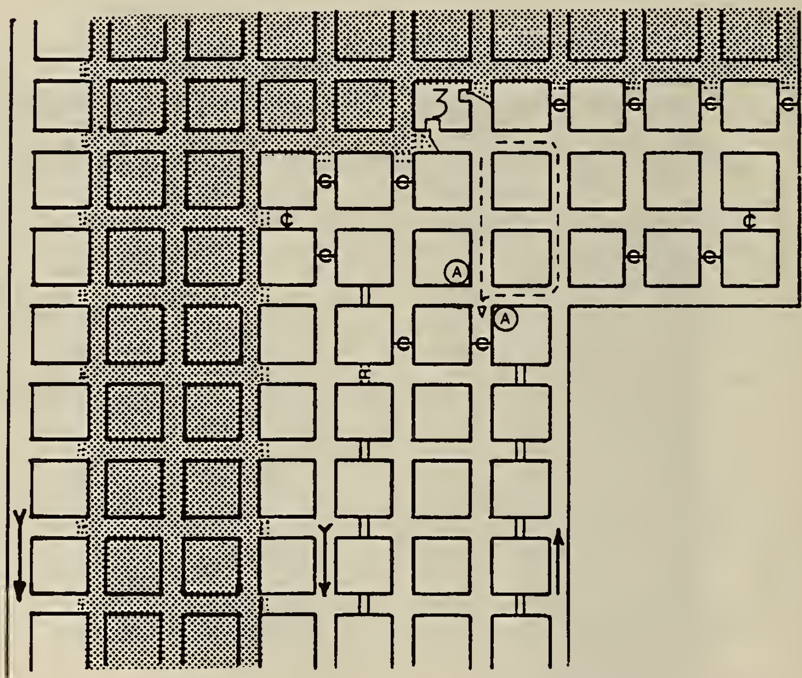
HO282021 Figure 87

The panel extraction sequence continues with the extraction of the third pillar.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: No change.

HAULAGE: Independent shuttle car paths are used. It is necessary to move the shuttle car anchor points.



LEGEND

Intake Air	Cable Anchor Point
Return Air	Shuttle Car Path
Face Curtain	Discharge Point
Check Curtain	Roadway/Turn Posts
Fly Curtain	Breaker Posts
Stopping	Cribbing
Regulator	Gob

Rooms Extracted on Advance and Retreat
Third Pillar on Retreat

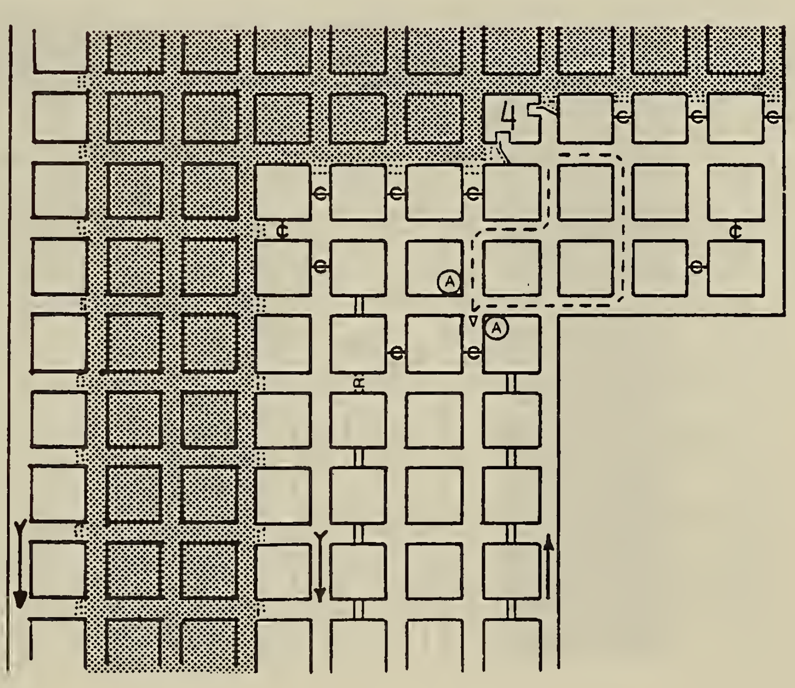
HO282021 | Figure 88

The panel extraction sequence continues with the extraction of the fourth pillar.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: No change.

HAULAGE: Independent shuttle car paths are used.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- -F- Fly Curtain
- Stopping
- =R= Regulator
- (A) Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- # Cribbing
- Gob

Rooms Extracted on Advance and Retreat
Fourth Pillar on Retreat

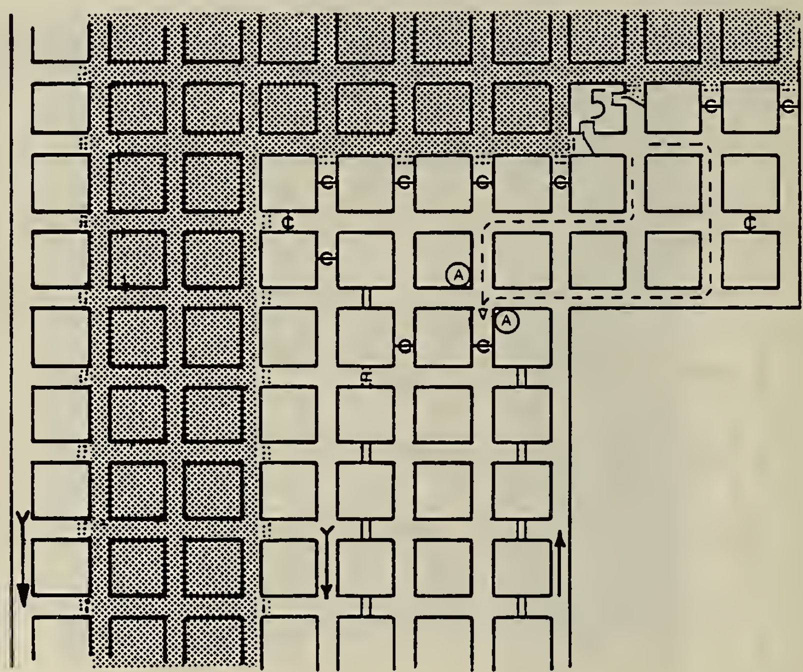
HO282021	Figure 89

The panel extraction sequence continues with the extraction of the fifth pillar.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: No change.

HAULAGE: Independent shuttle car paths are used.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Advance and Retreat
Fifth Pillar on Retreat

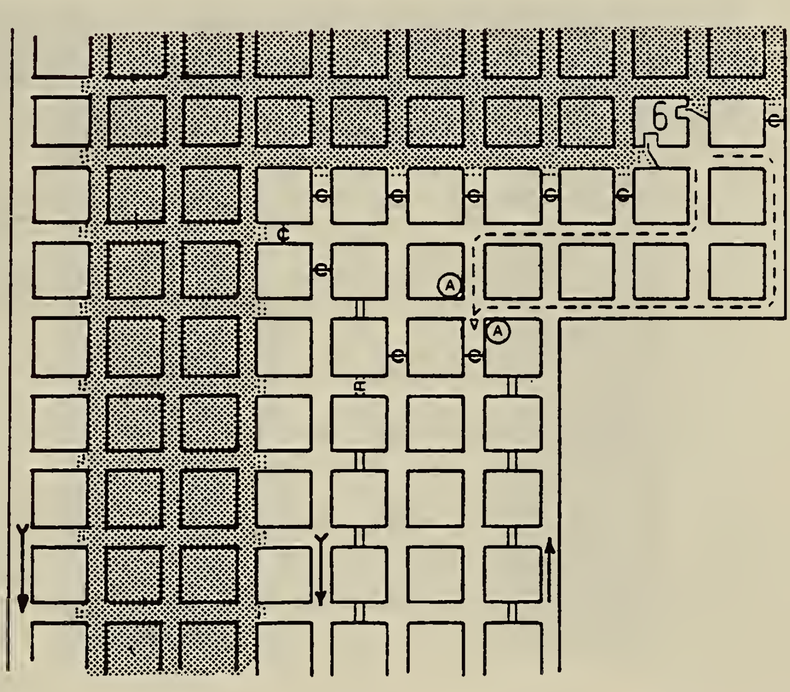
HO282021 | Figure 90

The panel extraction sequence continues with the extraction of the sixth pillar.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: No change.

HAULAGE: Independent shuttle car paths are used.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- -F- Fly Curtain
- Stopping
- =R= Regulator
- (A) Cable Anchor Point
- --- Shuttle Car Path
- ▽ Discharge Point
- .... Roadway/Turn Posts
- :::: Breaker Posts
- # Cribbing
- Gob

Rooms Extracted on Advance
and Retreat
Sixth Pillar on Retreat

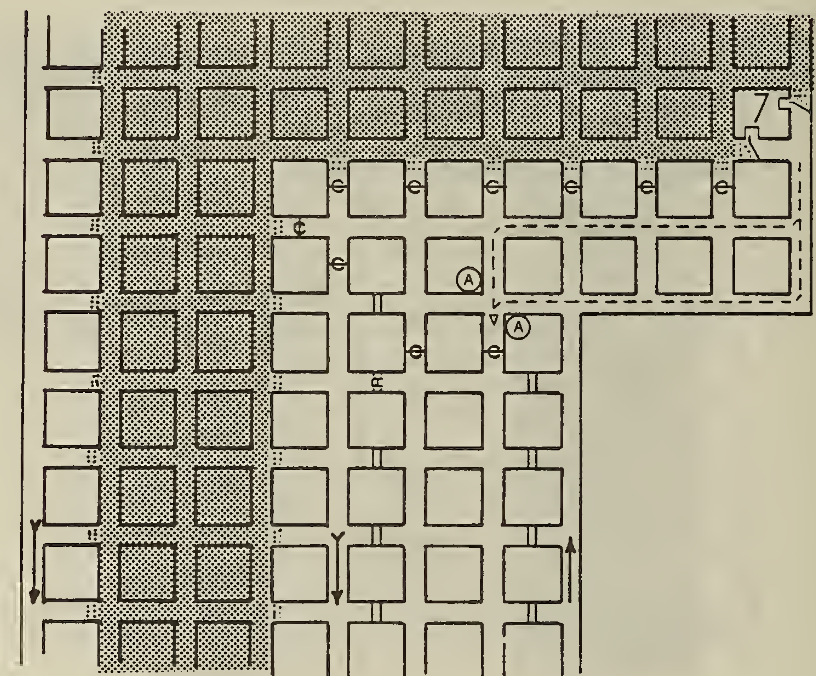
HO282021 | Figure 91

The panel extraction sequence is completed with the extraction of the seventh pillar.

ROOF SUPPORT: Breaker posts are set at all openings to the gob.

VENTILATION: No change.

HAULAGE: Independent shuttle car paths can be maintained outby the second crosscut.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Advance and Retreat
Seventh Pillar on Retreat

HO282021

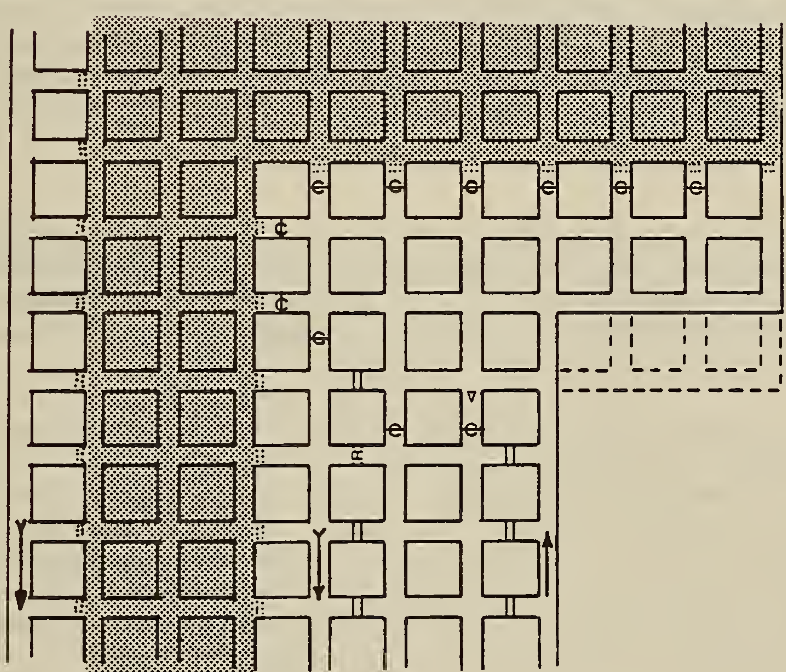
Figure 92

In preparation for extraction of the next row, a room entry is driven into the solid coal.

ROOF SUPPORT: Roof support is in accordance with the standard advance mining plan.

VENTILATION: Ventilation is in accordance with the standard advance mining plan.

HAULAGE: Haulage is in accordance with the standard advance mining plan. A belt move is required prior to initiation of mining.



LEGEND

- Intake Air
- Return Air
- Face Curtain
- Check Curtain
- Fly Curtain
- Stopping
- Regulator
- Cable Anchor Point
- Shuttle Car Path
- Discharge Point
- Roadway/Turn Posts
- Breaker Posts
- Cribbing
- Gob

Rooms Extracted on Advance and Retreat

HO282021 | Figure 93

Chapter 6. MINE PLANNING AND RETREAT MINING

In the preceding chapters, the reader has been presented with information that will aid in the selection and practice of a panel extraction method and pillar extraction process. All of this material, however, has been presented under the assumption that the operator has decided that retreat mining is desirable and the mine has been designed accordingly. To assist operators in making such a decision and mine planners in designing for retreat mining, this section addresses two points: whether to retreat mine and how to design a mine to allow retreat operations. The first section deals with deciding whether or not to retreat mine. Among the factors to be considered are the effects of geology, environment, labor, economics, and extent of extraction. The second section details those aspects of mine planning affected by a decision to retreat mine, including dimensioning of rooms and pillars, bleeder systems, and retreat mining and bumps.

Making the Decision To Retreat Mine

Geologic Considerations

The nature of the earth above and below a mine and the nature of the coal seam greatly affect the decision to retreat mine. Consideration must be given to the overall rock strata; the overburden composition; the mine floor; the coal seam; structural geology; the pitch of the coal seam; and multiple, overlying, and underlying coal seams. These factors are discussed below to highlight points important in retreat mining.

Rock Strata

The substance that comprises each stratum of rock in the vicinity of a coal seam is one of the major factors determining the strength of the roof and floor of a mine, which makes it a key factor in the decision to retreat mine. Some common rock types associated with coal seams and their properties as they relate to retreat mining are detailed below.

Coal.--A coal seam may be made up of different beds having somewhat different strengths and elastic properties. This can create high internal stresses and cause spalling of exposed surfaces when mining. Coal with a high ash content is likely to be a dull, dense, strong, attrital coal; a bright, shiny coal usually indicates a weak, anthraxylon coal, probably low in ash. A luster between bright and dull usually indicates a mixture of the two--coal is rarely composed of only one or the other--with a strength lying somewhere between their separate strengths. Many coal seams will have two fracture planes, the major or face cleavage and the minor or butt cleavage which runs perpendicular to the face cleavage. A semibituminous coal may have three or more fracture planes, making it a weaker coal. The strength of the coal is important in the design of the pillars and also in determining the susceptibility of the coal to bumps or bursts.

Shale.--Shale is found overlying most coalbeds and thus forms the immediate roof for those deposits. It may or may not be able to support its own weight. A good rule of thumb is, if a shale roof is 8 feet thick or more, it generally will be a good roof. This is because thick shale resists permeation by water. However, if the shale stratum is thin, particularly if it has

fractures, moisture can penetrate. Most shale deteriorates with exposure to air since it absorbs moisture. The water will reduce the adhesion of the shale stratum to the rest of the overburden, which could cause a roof fall. The nature of shale makes it a good roof for retreat mining since a clean, tight fall can generally be attained.

Slate.--As commonly used in the coal industry, slate is another term for a shale that splits into thin horizontal layers with straight cleavage planes. It is of various colors, black, gray, and green being the most common. Black slate has a high carbon content and may even approach coal in composition. As with other types of roof, slate can be strong or weak and may contain irregularities. Slate has a tendency to separate from other layers above it, causing hazardous conditions. Often it is taken down as the coal is extracted (a draw slate). Generally, it makes a good roof for retreat mining since a clean fall can normally be attained. However, extra support measures are required during advance mining when a fall is undesirable.

Draw Slate.--Draw slate is a general term for any shale, fire clay, or soapstone that comes down, or must be taken down, after the supporting coal has been removed. Draw slate usually contains many slips and cleavages that make it very treacherous. Where mining conditions permit, draw slate is often deliberately shot or cut down in the mining operation, especially if overlain with a better roof stratum. A limit to this practice is imposed by the tradeoff between (1) better roof support and mining conditions at the face and (2) increased contamination of the coal, which causes higher transportation, cleaning, and refuse-handling costs. Draw slate is not usually advantageous for retreat mining due to its unpredictable fall characteristics.

Sandstone (or Sandrock).--Sandstone often has so much shale in its binding material that it is really a sandy shale. If the grains are well cemented, sandstone can make a good roof during advance mining; however, during retreat, it may be difficult to get the sandstone to break and the roof to fall when desired. If the grains are poorly cemented, the reverse can be true, with the sandstone making a poor roof for advance operations but a good roof during retreat mining. Sandstone is highly porous, which means the presence of water can cause the sandstone to lose its adhesion to the rest of the overburden, resulting in a hazardous roof condition.

Bone Coal (or Boney).--Bone coal is a mixture of shale and coal frequently found at the top of a coalbed. Often, when bone coal is at the top of the bed, it is used for the roof if the thickness is sufficient to leave it in place. It varies in strength with the content of the shale or coal. Generally, it has good characteristics for retreat mining, particularly if shales are found on top of it.

Limestone.--Limestone usually has less faulty conditions than other formations because of its consolidated nature. Limestone does not often form the roof immediately above the coal to be mined; however, it may form the main roof. Limestone, like sandstone, may be a poor roof for retreat mining because of its massive nature and the resulting difficulty in getting clean falls.

Soapstone.--Soapstone is a varietal mass of impure talc. It may be white, gray, or greenish in color. Soapstone seldom has the strength to support its own weight and so is a source of many hazards. Soapstone, because of its weight and poor adhesion, seldom impedes roof falls, but its instability makes it undesirable as an immediate or main roof.

Fire Clay.--Fire clay is a deposit of mud that time and pressure have changed to rock. It ranges in color from white to deep gray and may be interspersed with coal, bone coal, shale, or sandstone streaks. It may occur over the coalbed, in it, or form the floor. For most coal seams, it forms the immediate floor. It may be hard and firm, or it may be soft. Usually it softens when exposed to air and water, creating muddy conditions. It can create hazards when present in the roof because of its poor adhesion to other strata and lack of strength.

Overburden Composition

Knowledge of the particular deposits making up the overburden is important in deciding whether to conduct retreat mining. The overburden affects pillar dimensions, equipment selection, roof control plan, and the selection of the mining technique. The overburden should be strong enough, given the proper pillar sizes and temporary support, to allow the development work to be done safely, yet weak enough to fall at the proper time during retreat mining. If this is not the case, variations in the pillaring plan, such as increasing or decreasing pillar dimensions or utilizing a different sequence of cuts, must be employed; or some other mining method, such as longwall mining, must be chosen. It is possible that extracting the pillars by the retreat method may be too hazardous or too costly. The overburden composition affects safety since a very weak overburden is dangerous and could fall prematurely during the pillar extraction process. A very strong overburden that does not fall soon after extraction of a pillar fails to relieve the pressure upon remaining pillars. This could cause the remaining pillars to fail, resulting in a dangerous, unplanned, and massive roof fall, causing injuries and the loss of much coal. Overburden composition also affects the economics of retreat mining in that either the cost of supporting a very weak immediate roof might be prohibitive, the size of the pillars needed to support the main roof might be too large (leaving too much coal) to be economical, or the cost of caving a very strong overburden might be too high.

Floor Composition

The composition of the floor under the coal is another important consideration. Often the floor consists of a fire clay that varies in thickness from a few inches to several feet. In the presence of water, fire clay, which might be firm during advance mining, could become mud during retreat mining and thus impede the movement of mining machinery.

The floor of a coalbed is frequently weaker than the roof; therefore, decisions concerning pillar size and mining method must be based partly on the composition of the floor. This is because the fire clay will have plastic flow under too much roof pressure, causing pillars to sink and the floor to heave. Further, the settlement of a pillar could cause the load formerly carried by that pillar to be transferred to adjacent pillars. When this occurs, the adjacent pillars could fail due to excess stress, or the strength

of the roof material could be exceeded, causing a roof fall. However, a minor floor heave could relieve stress in the roof at the rib line and improve roof stability.

Ideal mining conditions exist in mines with firm shale floors and sufficient yield in the roof, pillars, and floor. But if yield is low and overburden pressure is high (generally, over 1,000 feet of overburden), extremely hazardous conditions can result. Pieces of coal under extreme pressure will literally explode out of a block in a phenomenon known as a bump or a burst. Conditions such as these call for special mining techniques and are the subject of a discussion found later in this chapter.

Coal Characteristics

The composition and characteristics of the coal also affect the decision to retreat-mine. The physical properties of the coal dictate the value of the coal, its mining characteristics, its ability to maintain a rib or support the roof, and the type of warning it will give the miners as they work to extract the block. Coal geology and quality can, but do not necessarily, change within a specific coalbed. This depends on the original materials forming the coal and its exposure to geologic conditions. The coal should have a low modulus of elasticity (that is, the ratio of the load applied to the amount of deformation) so that the amount of energy released during failure is less and warnings of failure are evident. (See discussion of bumps at the end of this chapter.)

Structural Geology

Unusual conditions pertaining to structural geology can occur and may influence the decision to retreat-mine. Thinning of the coal seam due to erosion of the coal and replacement with roof material, downward bending of the roof into the coalbed, or upward thrusting of the floor produce areas with small amounts of coal (want areas) called rolls or pinches. Sections of shale, sandstone, mud rock, or clay are sometimes found cutting through a coalbed or the layers of rock on top of the seam, forming rock deposits or clay veins. These can cause slip planes that might make retreat mining hazardous.

Pyritic sulfur may occur in coal in the form of nodules or balls from a fraction of an inch to several feet in diameter. Sulfur balls impede mining and may slow down the rate of extraction of a pillar. Sometimes, oddly shaped masses that are not the same as the rest of the rock in the stratum are encountered. These may have been formed by mud that was packed into the space occupied by an old fallen tree trunk, a fossilized tree trunk, or minerals or bones of animals fused together. These formations are often referred to as horsebacks, kettle bottoms, or domes and are usually so poorly joined to the coal or to the rock in the roof that they may drop out unexpectedly. Special roof control measures may be required if these are encountered while mining a pillar.

Figure 94 shows some of these structures in mine strata. The mine planner must determine the existence or possible existence of such structures and, prior to making a decision to retreat-mine, ensure that adequate measures are taken to control these conditions and that the cost of control in

terms of dollars and potential hazards is sufficiently low to allow economical retreat mining.

Pitching Seams

The pitch of a seam can be a factor in determining whether to retreat mine. Slight grades increase haulage effort and time and decrease the amount of material that can be moved. As grades become steeper (approaching approximately 10 percent), standard equipment begins to lose traction. If the degree of pitch is too great, tramming of haulage and mining equipment may be difficult if not impossible.

The effects of seam pitch on pillar shape and weight distribution is another factor for consideration. A good pillar line is dependent upon the distribution of weight upon all pillars in the line. In flat seams, the weight of the overburden is symmetrically distributed. But as the degree of pitch increases, the weight of the overburden will become asymmetric as shown in figure 95. The end of the pillar carrying the most weight may start sloughing off and become so weakened as to cause the premature failure of a pillar in a pillar line.

Pitching seams occur in the Rocky Mountain region and in the eastern part of the Appalachian region where the coal seams are heavily folded. Folding of the strata can weaken them, causing roof problems. Pitching can also occur where the coal seam has been disrupted by faults.

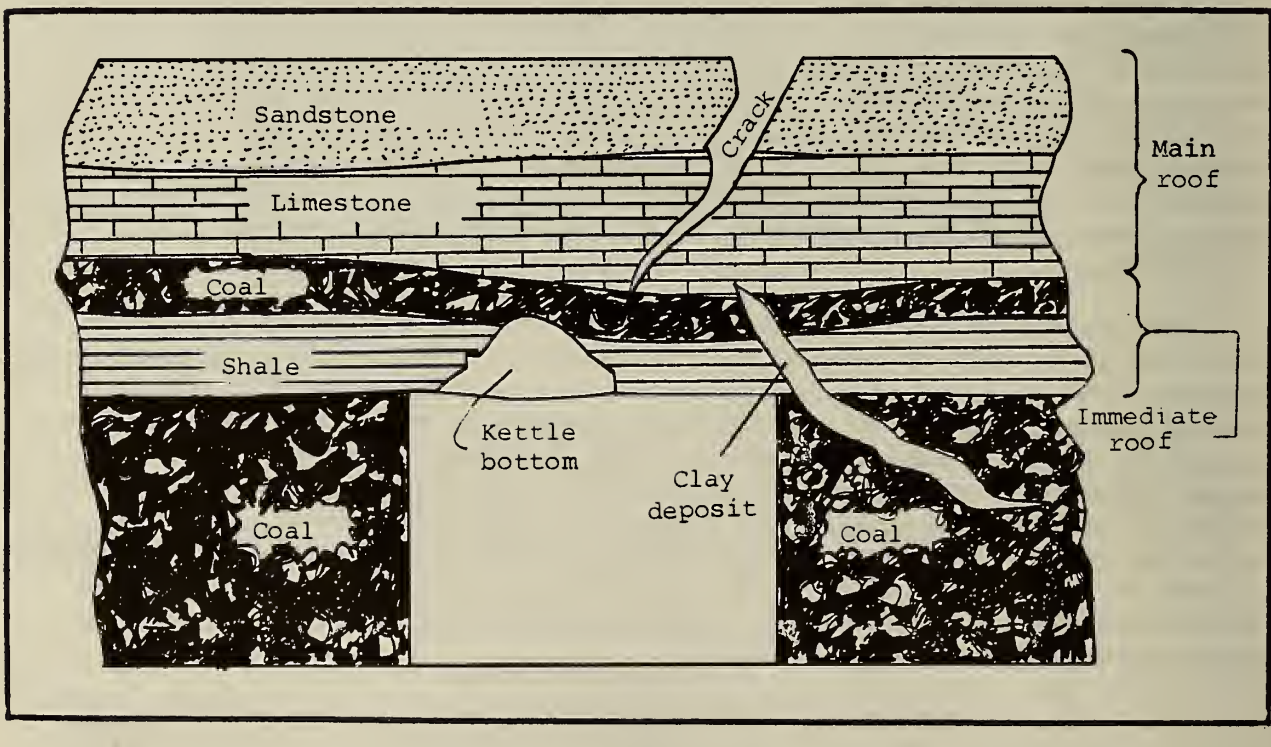


FIGURE 94. - Mine strata with intruding structures.

Multiple Seams

Multiple seams of coal can have a significant influence on the decision to retreat-mine. If no mining has taken place, consideration must be given to the proper order of mining the seams. If mining has taken place in another seam, this must be considered. Mining in adjacent seams might cause problems in subsequent mining and lead to a decision not to retreat-mine.

If mining of multiple seams is planned in a virgin coalfield, the proper order of mining is generally from top to bottom. This will aid in roof support and drainage but may result in the initial mining of a lower quality seam, which may affect the economics of the planned mining. It is also advisable to mine one seam at a time. Attempting to mine more than one at a time can be hazardous, especially when retreat mining, since the shock of a fall in one seam could trigger falls in the other.

Often, however, a decision to retreat-mine must take into account the extent of mining in other seams. A lower seam may have been more desirable and may have already been mined out. In subsequent mining of the upper seam, severe roof control problems may be encountered because of poor alinement or because the strata yielded as the lower seam was mined out. If retreat mining has been done in the lower seam, conditions are likely to be so poor in the upper seam that mining by any method is impossible.

When mining below a seam that was advance-mined only, alinement of the current mining with the previous rooms and pillars is desirable, but the mappings of the old works may be so poor that alinement is impossible. In some cases where this problem has occurred, remote sensing techniques have helped determine the layout of the abandoned workings. However, the degree of influence that the mined coalbed has on the unmined bed decreases with increased distance between the beds and increases with the thickness of the mined seam. The degree of influence is also dependent on the composition of the strata between the seams. It may not be possible to mine the seam immediately below a previously mined seam, but it may be possible to mine other seams located deeper within the strata.

Another factor for consideration is the possible presence of water in an overlying mined-out coalbed. After a mine has been abandoned, infiltrating water can flood the mine workings. Developmental work in the seam below is not likely to disturb the continuity of the strata between the seams, but Detreat mining is likely to cause fractures in the strata, which could lead to the inundation of the new mine by water standing in the old workings.

In summary, a decision to retreat-mine must take into account the question of multiple seams. Prior mining of seams might make retreat mining undesirable or perhaps even impossible.

Environmental Considerations

In the early stages of the decisionmaking process, there are basic environmental considerations associated with coal mining that must be addressed, including such factors as mine waste disposal, acid mine drainage, and reclamation. When retreat mining is being considered, certain other

factors must be evaluated either in addition to those normally considered or in greater detail. Two factors particularly important to retreat mining operations and discussed below are subsidence and underground hydrology.

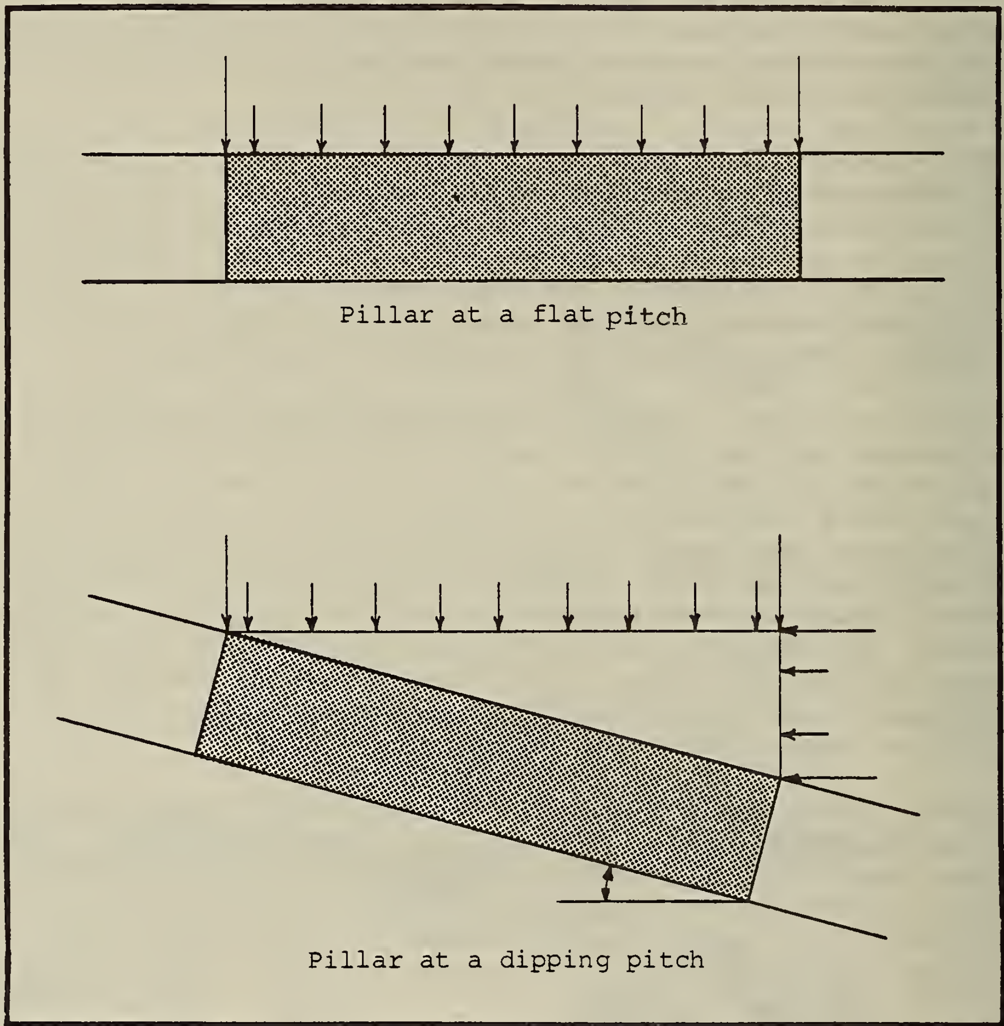


FIGURE 95. - Distribution of overburden weight.

Subsidence

When pillars are removed in the retreat mining process, the overlying strata subside into the resulting void. The critical factors related to subsidence can best be explained with the help of a two-dimensional model, (fig. 96).

The subsidence profile, or trough, is commonly described in terms of the angle of draw, seam thickness extracted, depth of the seam, and width of the mined-out area. The subsidence deflection, usually expressed as a percentage of seam thickness, increases as the width of the mined-out area increases up to a critical opening width, at which point the subsidence deflection reaches its maximum. The maximum is often about one-half of the seam thickness. The critical width can be determined by projecting two lines at the angle of draw down to the coal seam from a point on the surface.

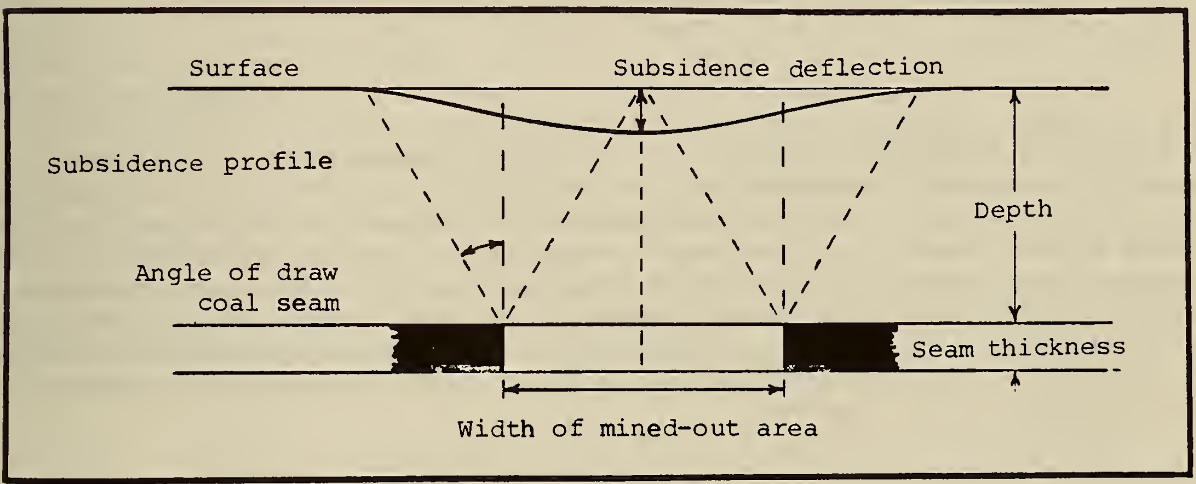


FIGURE 96. Two-dimensional model of subsidence.

In considering the implications of subsidence, it should be understood that there are horizontal displacements as well as vertical displacements on the surface; such displacements can damage or destroy surface facilities. As the surface subsides, horizontal displacement is compressive in the region above the opening and is tensile to either side of the opening, as shown in figure 97.

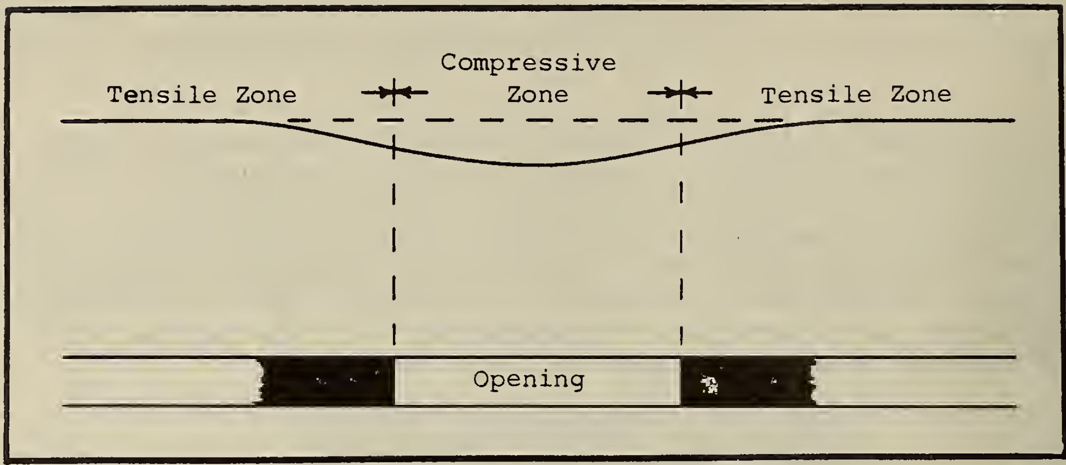


FIGURE 97. - Example of subsidence from underground mining.

In retreat mining, subsidence must be planned for as opposed to prevented. With complete or nearly complete pillar extraction, the top will inevitably collapse and subsidence will occur. Subsidence occurs within 1 to 2 days after the area has collapsed. Surface facilities located well within the limits of a uniformly subsided area may not be damaged. This is because most of the damage-causing, ground-length changes occur toward the perimeter of the subsided area. When areas are identified where subsidence is not allowable, such as under roads or buildings, a significant area below that area must not be pillared. This is due to the inverted cone effect of the subsidence area. If the surface area where subsidence is not allowed is very large, retreat mining might not be practical.

<u>Underground Hydrology</u>

Consideration must also be given to the fact that once the overlying strata are disrupted, as in roof collapse, there is a greater chance of affecting underground hydrology. The fissures and cracks allow surface runoff water to more easily permeate the overburden and may create pollution-causing acidic effluents. Analysis of the overlying strata prior to retreat mining can help to avoid acid-forming situations. Rock fracture zones and faults have a strong influence on ground water flow patterns, and often the fractures and faults collect and convey large quantities of water. Avoidance of these areas by pillaring operations may alleviate serious problems.

A complete hydrogeologic site evaluation to determine aquifer characteristics and waterflow systems is necessary before a decision to retreat-mine is made, because most underground mines receive water from overlying aquifers. The resultant roof collapse from retreat mining could

severely disrupt the natural aquifer conditions and cause not only polluting effects due to acidic mine effluent but also loss of necessary water for surface facilities and expensive pumping of water from low areas of the mine.

Labor Considerations

Labor is one of the most important issues facing the underground coal mining industry and is one of the primary considerations to be evaluated when making the decision to retreat-mine. Over the past decade, there has been a dramatic redistribution in the age of the work force. Table 3 illustrates this shift. As can be seen, the under-30 miners have increased steadily as a percentage of the number of workers. In 1975, underground coal miners under 30 years of age comprised 37.4 percent of the work force, and the figure is undoubtedly higher today. The problem caused by this redistribution is that much has been lost in the way of mining experience. In general, the older miners who have retired have not trained the new, young work force in the art of retreat mining operations. Because of this loss of experience, the hazards and problems associated with retreat mining will be even greater.

One of the purposes of this manual is to provide mines having only a few laborers experienced in retreat mining with a single source of information on the basics of retreat mining. It must be emphasized, however, that learning the feel and nuances of retreat mining by reading this or any other document is not possible.

In the process of deciding to retreat-mine, mine management will have to determine if it has the desire, ability, and patience to gradually and safely develop a retreat mining work force. An experienced retreat mining work force is not something that can be created hurriedly or easily. A work force with experience in the more basic aspects of advance room-and-pillar mining can be trained for retreat mining. A gradual program should introduce the method to the most proficient crew and, following initial success, expand it to the remaining crews.

TABLE 3. - Ranking of workers by age groups, 1966-75

	Age group				
	1966	1968-70	1971-72	1973	1975
Greatest number of workers-------	Over 50	Over 50	Over 50	Under 30	Under 30
2nd greatest number of workers---	40 - 49	40 - 49	Under 30	Over 50	30 - 39
3rd greatest number of workers---	30 - 39	Under 30	40 - 49	30 - 39	Over 50
4th greatest number of workers---	Under 30	30 - 39	30 - 39	40 - 49	40 - 49

Economics

Productivity on a retreat section can be significantly higher under certain conditions than on an identical advance section. Even in cases where productivity is not significantly higher on retreat, it is rarely significantly lower. Much of the supporting equipment that is required on a retreat section will have already been installed while on advance, but part of the resultant time saved will be spent installing temporary roof support.

The economic incentive to retreat mining is a matter not only of reduced cost but also of increased recovery. Recovery rates within a panel normally average as much as 65 percent for advance-only mining. Panel recovery percentages with the use of retreat mining can be as high as 80 percent. On a minewide basis, advance-only mining yields about 50 percent, while full retreat mining approaches 70 percent. The recovery rates may not have a great disparity, but recovery of pillars still yields a significantly greater amount of coal.

The mine engineer must assess the economic impact of retreat mining for a particular mining operation. The approach commonly used today is to perform an analysis using an econometric model. The model most widely used is a discounted cash flow (DCF) model, which allows for the decreased value of money over time.

In considering the possibility of retreat mining, the engineer must evaluate several potential advantages, including--

1. Decreased operating costs (productivity rates and supply costs).

2. Increased utilization of reserves (improved recovery rate of coal).

3. Extended life of the mine. (For a given acreage, more coal is available; thus, at a given production rate, the mine life is extended.)

The impact of retreat mining upon these parameters--operating costs, reserve utilization, and mine life--can be evaluated using the DCF model. Values can be assigned to the variables comprising each parameter, some of which may be estimated. Each variable may then be tested for its sensitivity to changes in the other variables attributable to retreat mining techniques. Any economic advantages of retreat mining that are identified will be significant in determining the overall profitability of a coal mining venture.

Mine Planning for Retreat Mining

Dimensioning of Rooms and Pillars

The following four factors are generally used to determine the dimensions of rooms, pillars, and production panels:

1. Rock mechanics
2. Equipment
3. Ventilation
4. Historical practices

The purpose of this section is to give the mine engineer sufficient information to evaluate the requirements of these factors and arrive at optimum pillar and panel dimensions. That is, the optimum dimensions are not necessarily the best for meeting the requirments of each factor, since one requirement may be in opposition to another, but are the best considering the requirements of all factors.

Basic Rock Mechanics Principles

Mine planners must consider the principles involved in supporting the overburden above a coal seam during the advance and retreat phases of mining so that these operations are undertaken in the most effective, safe, and economic manner possible. These principles should be applied in designing openings and pillars in entry sets, in designing rooms and pillars for subsequent retreat operations, and in determining appropriate roof support operations.

There are many rock mechanics theories being applied in the industry today, some of which appear to conflict and none of which contains the solutions to all problems or covers all the necessary considerations or potential situations. However, they can be used as guidelines, with the results from calculations being modified to suit the specific conditions of a particular mine.

This subsection provides some very basic rock mechanics theories to aid in understanding the principles behind entry, room, and pillar design and roof support techniques. The theories discussed are pressure arch theory, the Voussoir arch, and pillar strength.

Pressure Arch Theory

When an opening is driven into a coalbed, the immediate roof bends downward to free itself of the load from the main roof. The load from the main roof (about 1.1 pounds per square inch for each foot of depth) is then transferred to the remaining solid coal (abutments), forming a pressure arch. If the width of the opening is progressively increased, the pressure arch becomes larger and larger until the roof breaks; after this point is reached, the weight of the overburden will not be transferred to the abutments. The width of the opening just short of this breaking point is called the maximum pressure arch or critical width, and it will vary with the depth of the overburden from the surface. Figure 98 shows this relationship as experienced in United Kingdom and West German coal mines. The distance from the ribs that the solid coal can support the overburden load depends upon the thickness of the coal, the strength of the coal, and the overburden strata.

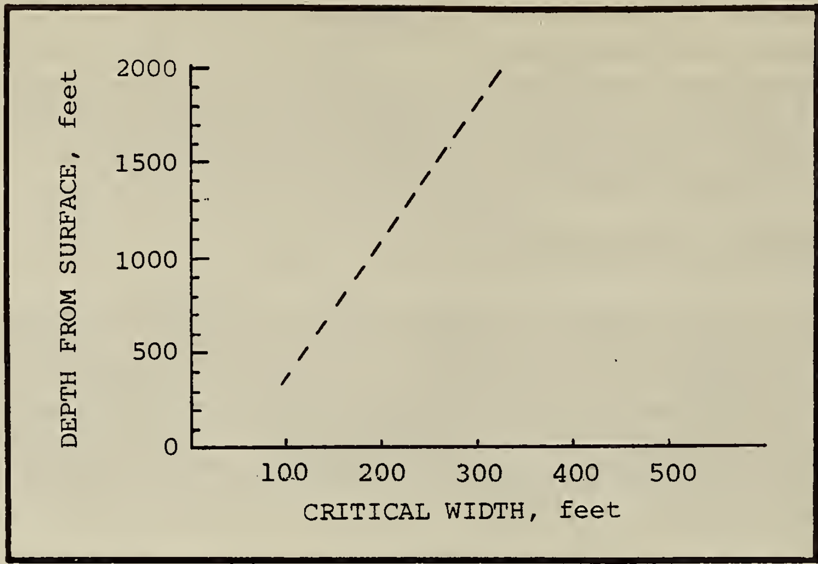


FIGURE 98. - Critical width versus overburden (empirical).

Figure 99 is a representation of the stresses acting upon the roof strata above a mine opening. Outside the arch line, the stresses are predominantly compression stresses; inside the arch, tension stresses dominate. Because rocks ordinarily have several times as much strength in compression as in tension, normally only the roof strata within the arching limit shown will require support.

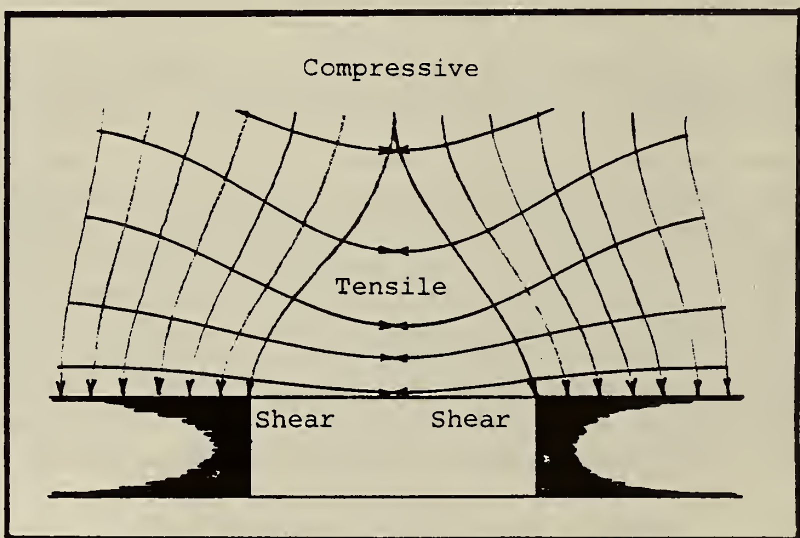
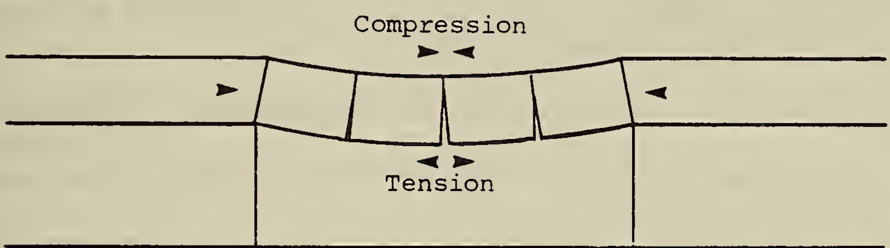


FIGURE 99. - Approximate distribution of roof stresses above an opening.

The Voussoir Arch

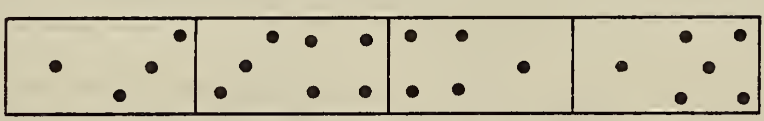
When an entry is driven into coal, the strata above the opening form an arch. If the strata are not cemented together, or if the cementing material has been altered, each stratum within the arch line acts as an individual beam. The action of such a beam under these conditions is referred to as the Voussoir arch principle.

Before a beam fails, it sags along its longitudinal axis. The maximum sag will be at or near the middle of the span, even though failure may occur at other locations (such as the ends). When the immediate roof stratum or beam above an opening sags, cracks will open up in the underside, forming blocks like a row of dominoes. The upper corners of the blocks are in compression, which holds the roof together. However, if the blocks are relatively thin or if the end pressure is not great enough, the roof will buckle through. On the other hand, sufficiently thick blocks or sufficient pressure will allow the span to be increased. Apparently, the roof will be most stable if the top of the beam is hard rock, since soft rock would yield under the compressive stress and would allow buckling. Figure 100 illustrates the Voussoir arch principle.



The immediate roof sags, forming blocks

Thin blocks like dominoes lying flat are unstable in vertical loading



Thick blocks like dominoes on edge are more stable in vertical loading

FIGURE 100. - The Voussoir arch principle.

The domino arch is very sensitive; it does not take much additional downward pressure to buckle it, but only a small amount of support at the center makes the structure much more stable. That is why small wooden props can often do so much for roof control. Also, the sensitivity of the arch increases rapidly as it deflects--the more it sags or bends, the more easily

it can fall. This kind of structure should be supported in a mine as soon after mining as possible before it has a chance to start bending.

Pillar Strength

There is a relationship between the strength of a pillar and its minimum width. If height is variable, the relationship will be between strength and the height-to-width ratio. For a given height, a wide pillar is much stronger, per square inch, than a slender pillar; for a given width, a short pillar is much stronger than a tall one. This means that using the same dimensions for all pillars in a seam in which the thickness varies a great deal is inappropriate. Also, in a tall, slender pillar, many flaws are exposed and the pillar tends to fall apart, but in a very short pillar, the flaws are confined and the strength of the pillar is great. A pillar with its width equal to or less than the height has minimal strength. When this condition is reversed, a pillar may prove to be extremely strong. For example, when the width is around 10 times the height, the perimeter of the pillar may yield somewhat but the center is confined. Then, between the two extremes, there will be some width at which the pillar does not collapse but creeps slowly for years until eventually it fails. This behavior may occur when width is around twice the height. (See fig. 101.) The ratios are given only for comparative purposes and are not necessarily reflective of the behavior of coal pillars. Actual mine conditions and the type of ore will determine the actual ratios. For example, for a coal pillar to be infinitely strong, the width might need to be 10 times the height.[4/]

4/ Parker, J. Practical Rock Mechanics for Miners, Parts 1 through 7. Eng. and Min. J., June-December 1973 and January-February 1974.

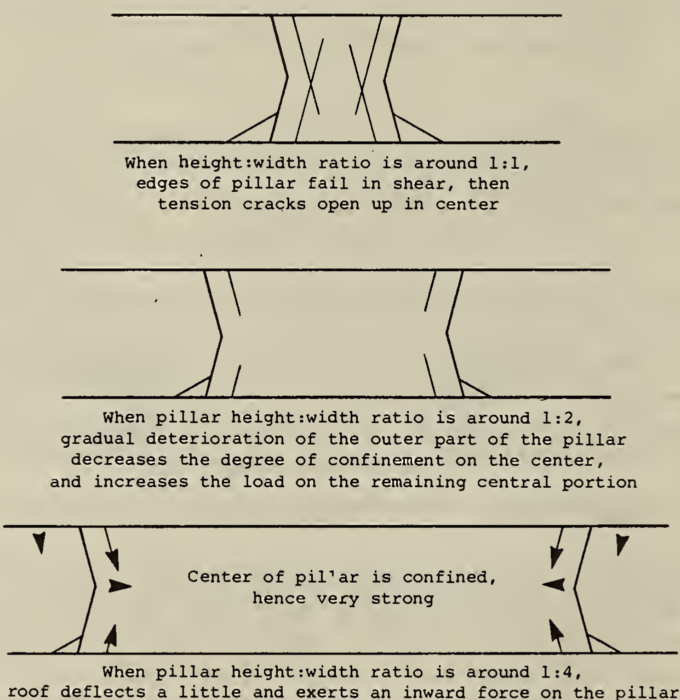


FIGURE 101. - Pillar strength versus height-to-width ratio.

Equipment

After completion of the dimensioning calculations based on principles of rock mechanics, the engineer will have determined the minimum pillar dimensions required to support the overburden pressures of the area. Within this framework, the engineer must then select pillar dimensions that will allow efficient use of mining equipment on section. The following discussion describes the calculations to be made in the selection process.

The working dimensions of the mining equipment must be considered when pillar dimensions are determined. An example of the required calculations is provided to illustrate the design process. In the example, the equipment dimensions for a continuous miner will be assumed. The two dimensions of the miner that determine optimum pillar size are cut width and miner reach. Miner reach is the distance from the machine controls to the front of the cutter head. These dimensions are as follows:

Miner cut width:	11 feet
Miner reach:	18 feet

Other assumptions to be made in the example are maximum pillar dimensions resulting from either ventilation requirements (which are discussed later) or haulage length requirements dictated by the equipment used; the minimum pillar size determined by rock mechanics principles (as discussed previously); and standard roof bolt spacing. The assumed dimensions are--

Maximum pillar dimension:	60 by 60 feet
Minimum pillar dimension:	40 by 40 feet
Roof bolt spacing:	4 feet

The pillar extraction process to be used in the example is the split-and-fender process. The calculations can easily be adapted to other pillar extraction processes as well.

The extraction of a pillar takes place by two types of cut. The first cut is the split cut. The split cut will be made to the depth of the miner reach from the last row of roof supports and will, in general, be the same width as the panel entries or crosscuts. In the example, the panel entries and crosscuts are assumed to be 18 feet wide. The roof bolting pattern of 4-foot spacings will result in a row of roof bolts 3 feet from each rib.

Since the roof bolts next to the ribs will be the last row of supports for the first split cut in the pillar, an initial split cut is 15 feet in depth (an 18-foot reach minus 3 feet to roof support). As stated, this split cut will be the same width as the panel entries or crosscuts (that is, 18 feet).

The placement of roof support in the first split cut on 4-foot centers will result in roof support to within 2 feet of the face. This means that the second split cut and all split cuts thereafter can be to a depth of 16 feet (that is, an 18-foot reach minus 2 feet to roof support).

The result of these split-cut dimensions is that split cuts will end at depths of 15 feet, 31 feet (15 plus 16), 47 feet (15 plus 16 plus 16), 63

feet, etc. Therefore, if the number of split cuts in a pillar is to come out exactly, the pillar length would ideally be 15, 31, 47, or 63 feet. However, as the next step in the example shows, setting the pillar length as an even number of cuts is not desirable.

When the final split cut is completed and the miner breaks through to the gob, a double row of breaker posts is placed across the end of the split before proceeding with removal of the inby fender. The inby row of posts in the double row should be in line with the rib line at the breakthrough. This requirement places the other row of posts 4 feet outby the rib line and means that the last row of roof bolts (or the next row of posts) will be 8 feet outby the rib line. The result of this roof support requirement is that if the last split cut in a pillar is over 8 feet from roof support to rib line, roof bolting will be required. Since encountering a delay for bolting after the split is completed is undesirable, the last cut should be kept within the 8-foot limit. Since the last row of roof bolts has already been determined to be 2 feet from the face before any given cut, the actual depth of cut for the last split cut will be only 6 feet.

Combining these roof-bolting requirements with the full split-cut dimensions presented earlier will result in the following optimal pillar lengths: 21 feet (15 plus 6), 37 feet (15 plus 16 plus 6), 53 feet (15 plus 16 plus 16 plus 6), 69 feet, etc. The first and second of these must be eliminated because they result in pillars smaller than the minimum dimension needed for roof support. The requirements of haulage and ventilation make the use of pillars larger than 60 feet undesirable; therefore, the optimum pillar length for the equipment and other conditions given will be 53 feet.

Now that the pillar length has been determined, the pillar width can be calculated. The primary factor in determining optimum pillar width is the dimensions of the second type of cut, the fender cut. The fender cut is a single-pass, angled cut into the fenders that are left after splitting the pillar. This cut should break through the fender into the gob to aid ventilation and roof control.

The dimensions of this cut will be the cut width (11 feet) and the miner reach (18 feet). However, since this cut is taken on an angle, these dimensions must be adjusted to arrive at a desirable fender width. For purposes of this example, the cut will be taken at an angle of 60°. Figure 102 shows the miner reach and its equivalent fender width.

This figure shows that a fender 12.6 feet wide can just be broken through by a miner with an 18-foot reach at a 60° angle. In order to be somewhat on the safe side for breakthrough, a fender over 12 feet in width is probably not desirable. This fender width, when combined with the split width of 18 feet, results in a pillar width of 42 feet (18 feet plus two 12-foot fenders). Since 42 feet is within the dimension range determined by rock mechanics and haulage and ventilation requirements, this pillar width is acceptable. Thus, in this example, the optimum pillar dimensions for equipment efficiency, within the limitations of rock mechanics and other considerations, will be 42 feet wide by 53 feet long.

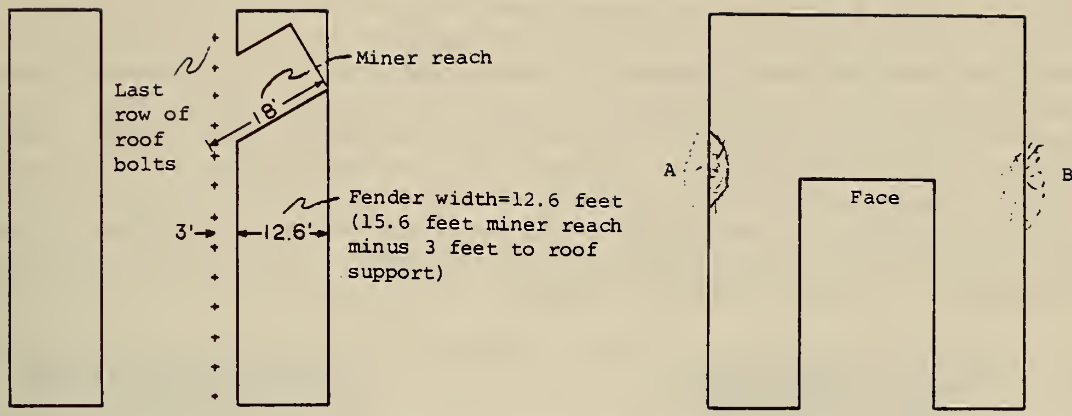


FIGURE 102. - Optimum fender width.

Ventilation

Ventilation requirements rarely affect pillar dimensioning directly. However, they do affect the size of entries and thus may indirectly affect pillar size. Ventilation requirements may also determine the number of entries needed in a section. This factor, in combination with equipment limitations, can affect panel width and thus pillar dimensions.

Historical Practices

Unfortunately, history is frequently the sole determining factor in establishing pillar size. There are many areas of the country where a particular pillar dimension is used simply because everyone in the area has always used that size. There are two points of discussion concerning this tendency.

One point frequently made in favor of the historical approach is, if a particular size has been working under the conditions of a particular area, there is no apparent reason to change it. This is a powerful argument, and the plans that are working in a particular area should be given definite consideration in the process of establishing the dimensions of developing panels. However, the second point is that the plans that have been used in an area over many years may have been developed under entirely different conditions. The mining plan that may have been optimal under the roof and equipment conditions of 30 years ago may not be at all efficient today. Therefore, historical practices should be a part of the decisionmaking process but not the sole determining factor.

Bleeder Systems

One of the requirements of the 1969 Coal Mine Health and Safety Act that has strongly impacted the practice of retreat mining is the requirement for

bleeder entries or systems. In virtually all retreat-mining operations, a bleeder system will be required. Bleeders are entries that encircle a mined out area. The purpose of these entries is to bleed methane and other explosive gases from a gob area and move them into the main return airways. The principle behind bleeders is that air enters the mined out area from the intake air side, filters through the gob area, and carries methane and other explosive gases into the bleeder entries and finally into the main return airway and out of the mine. Bleeder entries should be maintained free of excessive water accumulations and roof falls to be effective. The top of bleeder entries should be well-supported and they should be accessible for periodic inspection. Only in those areas where partial oxidation of exposed areas could result in spontaneous combustion will the practice of sealing caved areas be substituted for bleeders.

There are three areas of design that result in differences between the various bleeder systems:

1. The method by which air is conducted through the panel.

2. The connections, or lack thereof, between panels.

3. The method by which return air is collected from groups of panels and routed to main return entries.

Each of these design areas and their relationships with one another will be discussed in the material that follows.

<u>Panel Bleeding</u>

There are primarily two alternatives available for the bleeding of individual panels--total extraction and incomplete extraction. Total extraction of a production panel involves the second mining of all possible pillars in the panel. Air must be able to flow through the gob that remains after the extraction is completed. In many cases, after extraction is completed, the gob falls tightly, compacts itself, or even cements itself together in such a manner that it will not conduct air. The practice of bleeding requires that a differential air pressure be established that will cause air to flow from the gob into the bleeder returns. If the gob is packed so tightly that airflow is not possible, the total extraction of individual panels will not be possible.

The alternative to total panel extraction is incomplete panel extraction, which is the practice of systematically leaving a row of pillars to provide an air passage through the panel. Incomplete panel extraction should not be confused with partial pillar extraction, which is the practice of extracting individual pillars in such a manner that caving of the main roof is not achieved.

Figure 103 compares panels extracted using the two different methods. The panel on the left has been totally extracted, with the return air percolating through the length of the gob into the return entries. The panel on the right has beeen incompletely extracted, leaving the pillar between entries 1 and 2. This pillar protects entry 1 from closure. This entry will

be connected to the return and will serve as a source of constant negative air pressure to bleed the panel.

A dense, consolidated, blocky immediate roof would tend to form a loose, porous gob that could be bled successfully with total extraction. At the other end of the scale, an unconsolidated, laminated immediate roof would tend to form a dense, compacted, impermeable gob that would require incomplete panel extraction for successful bleeding.

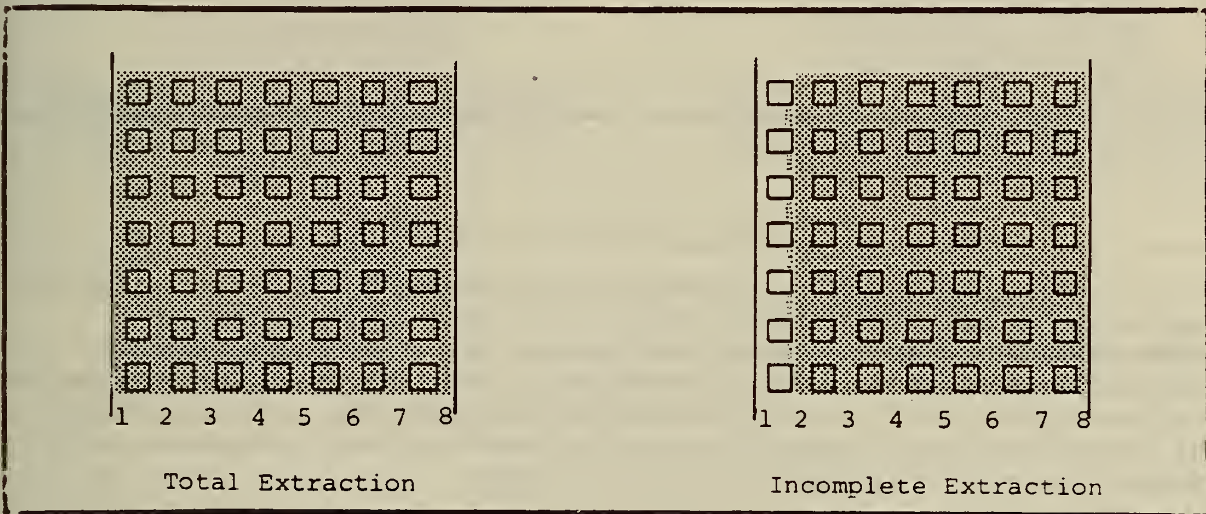


FIGURE 103. - Panel bleeding.

Panel Interconnection

As with panel bleeding, there are two alternatives for panel interconnection--interconnected and independent. In interconnected panel design, there is no barrier pillar between panels, and the gob from one panel is contiguous and generally indistinguishable from the gob of other panels. Using this system, the entire interconnected gob is bled as a unit with the return removing contaminated air from the group. When using independent panel design, a barrier pillar is maintained between panels and each panel is bled as an individual unit. The bleeder returns receive air from each panel rather than from groups of panels. Figure 104 shows interconnected and independent panels.

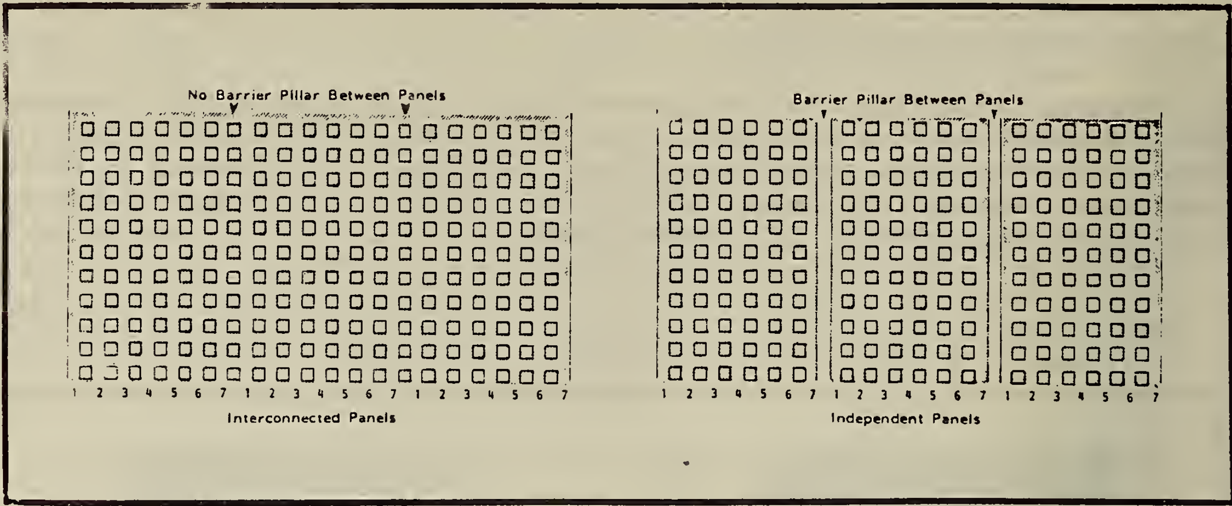


FIGURE 104. - Panel interconnection.

In a practical sense, it is frequently desirable to maintain independent panels during the developmental phase of the panel life and then to interconnect the panels by removing the barrier pillar as the panel is retreated. This provides needed ventilation control while on advance and yet has the simplicity of interconnected panel bleeding when the panels are completed. The panel design discussed in the "Full Panel Extracted on Retreat" section of chapter 5 is such a system.

Because of the larger area subject to common bleeding, the interconnected panel bleeder design requires the presence of a relatively open gob. A closed gob that accepts airflow with difficulty will necessitate the use of independent panel bleeding. The desire to provide independent control and monitoring of individual panel bleeding is also a strong factor in favor of independent panel bleeding. The major advantages of the interconnected panel bleeder system are its simplicity and higher rate of recovery (no losses in barrier pillars between panels).

Panel Connection to Returns

The third area of bleeder design is the connection of the panel bleeders to the main returns. Design options are to provide a separate bleeder entry or to use existing panel development. These are illustrated in figure 105.

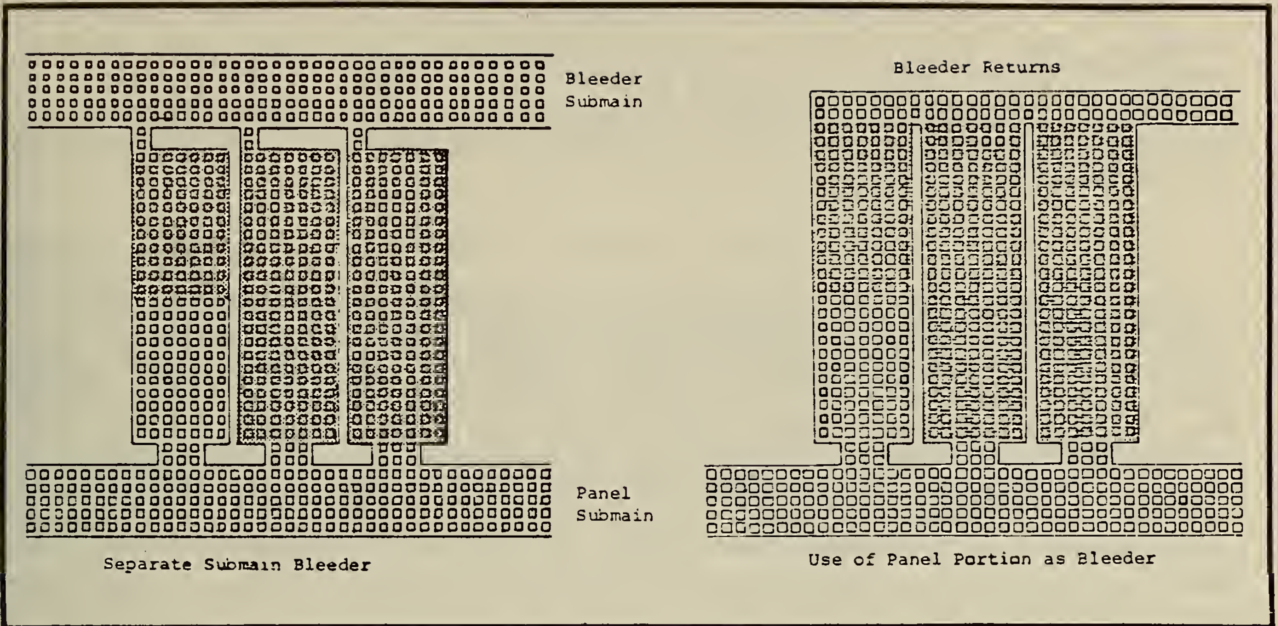


FIGURE 105. - Panel connection to bleeders.

A separate bleeder entry has many advantages in terms of control, dilution, and bleeder design, but it results in great sacrifices in terms of reserve recovery, cost, and possibly productivity. In the practice of providing a separate bleeder entry, two sets of submains will be driven for each set of production panels. The panels will be developed from one set, and the bleeder connection will be made to the other set when panel development is completed. The first set of submains will be used for haulage, supply, and primary ventilation. The second set of submains will be used as bleeder returns only. If necessary for gas dilution, intake air can be run in part of the bleeder submains and mixed with the return air as it enters the submain from the panels. This practice is expensive and should not be done if other solutions to the gas concentration problem can be found.

The use of existing panel development entries (or crosscuts) is a more efficient and easier process if conditions permit. In this system, the panels are developed to their extremities, and the extreme inby rows of pillars are allowed to remain. Connections are made between the standing sections of the various panels, and these connected sections are used as the bleeder return. Some control of individual panel ventilation is sacrificed in using this system. In addition, fewer panels can generally be ventilated using this system than with a separate bleeder submain. Even with these sacrifices in control and panel grouping, however, the use of this system if the panels can be successfully bled is generally desirable. One of the conditions that might necessitate using a separate submain system is a condition of extremely high gas emission. In this case, blocking out entire production panel sections prior to mining to allow some gas bleedoff may be desirable. This is not possible with the use of existing panel entries for bleeder returns.

These alternatives indicate that there are eight basic bleeder system designs. Since some of the design alternatives are beneficial under similar conditions, there likely will be a tendency to use them together. For example, the conditions that favor total extraction also favor interconnection, and therefore there is an expectation that the two would normally be used together.

Retreat Mining and Bumps

Under certain conditions, coal can be subject to sudden releases of stored pressure. These releases, known as bumps or bursts, frequently resemble explosions and can involve the expelling of significant amounts of coal. Bumps can easily result in damage to nearby equipment and injury or even death to personnel. Where these conditions exist, retreat mining becomes a delicate operation that must be performed with caution and precision. If certain precautions are taken, however, there is no reason that retreat mining cannot be conducted under bump-prone conditions. The following discussion will describe the conditions under which bumps are likely to occur and then will present the techniques for successful retreat mining in bump-prone areas.

Bump Conditions

The conditions that result in bumps can be divided into geological conditions and physical conditions. Geologically, the primary prerequisites are a hard, unyielding roof and floor. When mining takes place in a seam between a hard roof and a floor, the energy generated by the inevitable (if minute) roof movements cannot dissipate itself into the lower strata; therefore, it is stored. Over time, a significant amount of energy can build up in the coal pillars. If this stored energy is slight, bumping will not occur. Because of this, bumping rarely occurs in areas where the overburden is less than 500 feet but becomes a common problem if the overburden is 1,000 feet or more.

Another geologic condition involves the coal type. The areas that have the severest problems with bumps generally have coals that are of a spongy, energy-absorbing nature. These coals store large amounts of energy until they reach their yield points and then fail suddenly and often catastrophically, releasing this energy in one burst.

In summary, there are three geologic conditions that contribute to bumps:

1. Hard roof and floor
2. High overburden pressures (1,000 feet or more)
3. Energy-absorbing coal

In addition to these geologic conditions, certain physical conditions contribute to the occurrence of bumps. The two major physical contributions are--

1. Nonuniform size pillars, particularly a single large pillar in an area of smaller pillars.

2. Hanging roof falls.

In the former case, the smaller pillars are likely to yield for stress relief. Most of the load is then transferred to the large pillar. If the load is too great and too much energy is stored in the pillar, bumping may occur. In the latter case, the load from a hanging roof fall will be transferred to the surrounding pillars. Again, if the load is too great upon these pillars and other bumping conditions prevail, they may be subject to bursts.

Mining Practices

Although retreat mining under bump conditions is not an exact science, a number of practices have been found to be successful through trial-and-error testing. These techniques are largely based on the following:

1. Bumps occur in pillars that are in a certain "critical" size range. Pillars larger than the critical size appear to be incapable of storing sufficient energy to bump. Pillars smaller than the critical range have already yielded and cannot store energy.

2. Bumps generally occur along the pillar line where pressures are highest.

3. Bumps usually occur on the long side of a pillar. This fact is important because mining performed on the short side of a pillar is relatively safe. Figure 106 is helpful in illustrating this point. The pillar in this figure is in the process of being split. The most likely locations for bumps during this splitting process are marked at A and B. These two locations are on the long side of the pillar, approximately opposite the working face. Obviously, personnel should avoid the areas around points A and B.

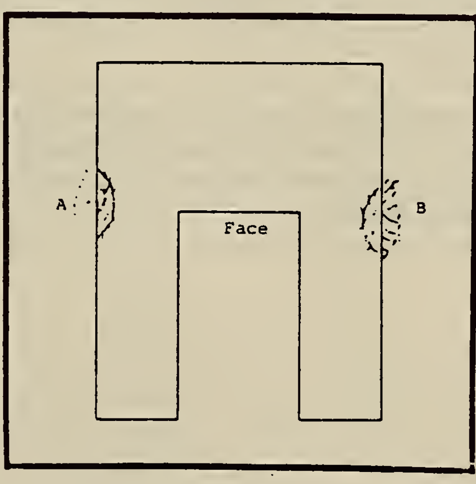


FIGURE 106. - Pillar locations susceptible to bumping during mining.

Some of the practices that are used to control bumping are described below:

1. Uniform size blocks are mined, particularly in sections that will be undergoing retreat mining at some future date. Uniform blocks tend to eliminate load concentrations that can be the site of bump problems.

2. When mining on retreat, rooms are developed on very short centers to the left or right of the main panel, leaving relatively small blocks of coal that can be taken as fenders (the outside-lifts method). The solid coal into which the original rooms are cut is too large to be sufficiently loaded to cause bump problems. The small pillars that remain after the rooms on narrow centers are cut are sufficiently small that yielding has occurred, and bumps will not occur in them. The difficulty in this mining plan is primarily in the mining of the chain pillars in the entry panel itself. There are other techniques used for mining these pillars.

3. To mine chain pillars and other developmental pillars, size-reducing cuts, known as bump cuts, are made relatively far ahead of the active pillar line. In executing this method, the section crew will make outside cuts or even sometimes full splits into chain pillars or other developmental pillars two or three crosscuts in advance of the retreating pillar line. The difficulty with this method is that, when making size reducing cuts in the pillars, the crew must pass the pillar through the critical size during which it is subject to bumps.

4. Any cut or significant reduction in size of a pillar is done rapidly before the overburden pressures have sufficient time to rest on a pillar and allow it to absorb sufficient loading to bump. This principle can be used when performing the previously described method. In this case, it is essential that the bump cuts or size reducing cuts be made in a rapid and expeditious manner so that they can be completed and removed from the pillar before the load has had a chance to settle into the area.

5. Cuts are made in the small side of rectangular blocks being split or reduced. A crew should be cautious of the area adjacent to the face along the rib of the outside of the long side of the block because it is prone to bump activity.

Mining Operations

Whether using conventional or continuous mining equipment, the proper execution of mining operations is essential to obtain acceptable productivity levels. This is particularly important in retreat mining where the failure to follow basic principles of mining can not only cause serious delays but also increase exposure to hazardous conditions and lead to the loss of valuable resources. There are four specific areas in which the section foreman can make improvements in mining operations: the preparations for mining in a place; the mining of pockets, splits, fenders, wings, and pushouts; the completion of mining in a place; and the execution of the place change. Each of these areas is discussed in the section below.

Place Preparation

Before beginning the mining operation, the foreman must take steps to ensure that the working place is safe. Roof and rib falls are the leading causes of fatal accidents in the coal industry. This is of particular significance in retreat mining where changes in roof pressures can create rapidly deteriorating conditions. The nature of retreat mining dictates that conditions will have deteriorated since the last cut was taken in any given place. Therefore, it is important to take the time to carefully test the roof and scale down any loose material prior to the beginning of mining. Ribs, too, must not be overlooked. As the pillar takes pressure, sloughing of the ribs will create additional hazards. All corners and notches should be examined to ensure that they are adequately supported.

On occasion, debris carelessly discarded has been picked up by the miner's cutting head and flung at workers in the area. This is even more likely to occur in retreat mining because of the quantities of cap blocks, wedges, and other pieces of timber discarded as the posts are set. Therefore, debris along the roadway or at the face should always be cleared away.

An efficiently operating section is an orderly section. Posts to be set should not be carelessly tossed in a pile at the point of the pillar split. Rather, they should be stacked neatly and as close to the point of use as possible. Saws and other tools should be left in a convenient place, easily seen, but out of the way. Curtains or air ducting should direct the air current in the proper course. A methane concentration check should be made.

Mining in a Place

The mining operations differ slightly when mining pockets or splits, fenders or wings, and pushout stumps. Before mining the pocket or split, the foreman must apply basic survey techniques and must take the time to carefully measure the point at which the cut is to be initiated. Whether using conventional equipment or a continuous miner, failure to properly determine the point at which to initiate the cut can lead to improper dimensions of the fenders or wings. This could cause pillar failure and subsequent injury or create a situation where the crew is likely to go beyond supported roof to obtain complete extraction. Site lines should be made on the top,

and site rods should be hung to assist the continuous miner operator in maintaining direction.

Additional roof bolting prior to initiating the pocket or split is recommended. By installing roof bolts against the rib, as much as 20 percent more coal can be extracted in a given cut.

In making the split with a continuous miner, the box cut on the right should be advanced 10 feet. At this point, the continuous miner should be pulled back and the curtain advanced to the face. The cut on the left then can be advanced a full cut (up to 20 feet) because the curtain is now still within 10 feet of the face. Last, the final cut on the right hand side can be completed.

Once the pocket or split is completed, the next step is to extract the fender or wing. These operations are the more productive part of retreat mining since no roof bolting is required, but they should be performed with extreme caution due to the hazards involved. The roof control plan is a guide for the extraction of fenders or wings. It reflects the experiences of the mining company and of the mines in the immediate area. The experience of the crew is also important in determining exactly how much coal can be extracted.

After turn posts are set in preparation for the extraction of the fender or wing, the continuous miner should be turned between 30° and 45° to extract the fender. These cuts are generally taken to the right, keeping the miner operator against solid coal. However, in the pocket-and-wing methods, some cuts must be taken to the left. In these instances, more coal can be extracted while under support because the reach of the continuous miner while turning to the left is significantly longer. Discretion should be used, however, since the operator is no longer against solid coal.

When the splits are being roof bolted, the subsequent mining of the fenders and wings should be considered. Bolting should be close to the inby fenders and wings; this will provide a greater margin of error to the equipment operator to prevent mining in unsupported areas.

As the mining of the fender or wing progresses, the miner operator's helper should be positioned to watch both roof and rib conditions and activity in the gob. Small stumps of coal can be left to act as indicators as the remaining coal is removed.

The mining of pushout stumps is the most hazardous stage of pillar extraction and should only take place with the foreman present. Care should should be taken to ensure careful adherence to the roof support plan. Spot bolting close to the rib should take place prior to the extraction of the fender or wing.

A double row of breaker posts should be installed on both sides of the roadway leading to the final stump. The roadway should not exceed 14 feet in width. Only one roadway should be maintained to the final pushout.

The mining of final stumps must be done with a minimum of delays. Once mining has commenced, it should not cease until the stump is extracted or

abandoned, since roof deterioration is rapid. The proper method of extraction is to hit the stump head on. Attempting to narrow the stump from the side is a more hazardous method of mining. As much coal as can be safely mined should be taken. Under no circumstances should miners go beyond supported roof.

Completion of Mining

When mining of a pocket or split is completed, the equipment should be pulled back and a danger sign hung pending the installation of roof support. After the area is roof-bolted, the place should be thoroughly rock-dusted. If a scoop is available, it is also worthwhile to thoroughly clean all loose coal from the pocket or split. This coal should be placed at the face so that it can be loaded out before the initiation of the next cut. This cleanup is part of good housekeeping and will pay dividends as the remainder of the pillar is extracted.

Place Changes

The proper execution of the place change is one of the most important components of a high-productivity section. A place change from one block to another can normally be executed in under 10 minutes. By utilizing the techniques shown earlier in this manual, check curtain moves and shuttle car anchor point moves are kept to a minimum; the movement of the continuous miner should be the only time-consuming operation. The equipment cables should be fastened to the equipment so that the tramming of the equipment pulls the cable in the appropriate direction. Attention must be given to the location of the cables in the entries to minimize the amount of time spent in hanging cables. The movement of a piece of equipment is a team operation and requires four or more people. The section foreman must ensure that adequate labor is available and that individuals know their proper assignments. Noncritical operations should be stopped temporarily and labor reallocated to assist in the move. Remember, time lost in moving from one working place to another can never be regained, and production and productivity will suffer.

Many mining crews move the equipment quickly only to encounter delays for other reasons once the equipment is at the new face. The foreman should ensure that place preparation is completed prior to the initiation of the place change. All ventilation curtains should be hung, timbers and posts should be installed, and sights should be set. Once the continuous miner trams to the face, the crew will have only to make the necessary safety checks. Then mining can commence.

Conventional mining requirements are not vastly different. Except for the complexities created by the additional equipment, the same principles apply to conventional mining as were discussed for continuous miners. Usually, the movement of one particular piece of equipment is the key to the whole system. The section foreman should ensure that this particular operation is adequately staffed so that it does not create delays. Cable handling is perhaps more difficult due to the possibility of tangling cables. A set procedure must be followed in moving equipment to avoid tangling cables.

Roof Support Operations

Roof control devices such as timbers and posts are intended to support the immediate roof--the rock that lies directly above the coal seam. Coal pillars provide support for the main roof. In advance mining, the intent is to keep the roof in a stable condition, since any deterioration in the roof is irreversible; it is best to prevent the roof from moving at all. In retreat mining, the strategy is somewhat different, because some yield is desirable. Pillars should begin to take weight. As a pillar is extracted, more and more weight is held up by a smaller part of the pillar.

After extraction is completed, a quick fall is desired, so too much roof support in terms of coal left in stumps, roof bolting, and timbers and cribs could be detrimental to the efficient operation of the section. Therefore, minimal roof support should be installed provided that sufficient allowance is made for variations in conditions.

Roof Bolting

Roof bolting is required in all areas inside the pillar block where personnel will be actively working. Pockets or splits are supported to within 8 to 10 feet of the end. The remaining areas need not be bolted, but breaker posts should be set to isolate them so that the remainder of the coal in the fenders may be extracted from a safe position.

Roof bolts should be inserted as close to the face as possible. If, after installing roof support, 2 to 3 feet remain between the last row of bolts and the face, one more row of bolts tight against the face will improve productivity since it will allow the continuous miner to advance deeper into the coal. Similarly, since coal will eventually be extracted on the gob side of the split, the installation of roof support tight against the rib on that side is also advantageous. Bolts should be inserted close against the rib also at all points where pockets or splits are to be driven. The roof bolting in these three areas should occur prior to commencement of mining.

The area where the final pushout stump is to be recovered should not be overlooked. Again, roof bolts should be inserted as close to the rib as possible and in the early stages of pillar extraction; installing any additional roof support safely will be difficult once the pushout is ready to be recovered.

All areas where roof bolting is not necessary should be posted. Once the pocket or split is driven to within 8 feet of the end of the block, the remaining coal can be extracted safely without additional roof bolts, but posts must be installed to provide necessary support prior to mining.

Timbering

Timbers are used in abundance in retreat mining as breaker posts, turn posts, roadway posts, and cribs. The posts themselves do not differ at all in construction; however, the theory of application is different for each use, and each merits separate discussion.

Breaker posts are set at each entry that is exposed to the mined-out area. Primarily, breaker posts act as a continuation of the pillar line, filling in between one pillar block and another so that the roof breaks along a straight line. Without breaker posts, a roof fall may ride between pillar blocks into entries. Breaker posts also serve as warning devices to indicate the entrance to a dangerous area. Breaker posts are set commonly in double rows, two posts set close together on 4-foot centers. In some areas where conditions are extremely hazardous, cribs may be set in lieu of breaker posts.

Turn posts are used to provide protection for the equipment operators. They should be installed anytime cuts are taken in fenders or wings and at the entrance to all splits or pockets. Turn posts alone, however, do not adequately support the roof. Therefore, they should be viewed as indicators of movement in the roof, not as support.

Roadway posts are installed along the roadway prior to the extraction of pillars. They are intended to decrease the width of the roadway to a maximum of 16 feet. (A common assumption is that the maximum safe entry width is 20 feet.) As pillars are extracted, the perimeter of the pillar will deteriorate to a point at which the pillar is no longer effective in holding the roof. The installation of roadway posts is an important step to make up for decreases in the effective load-carrying capability of the pillar.

Cribs are used in place of breaker posts in many areas where conditions are hazardous. Typical locations are inby the split in rooms or crosscuts or in place of the breaker posts in preparation for the final pushout stumps. Cribs, being more expensive, are commonly recovered where possible.

Section Ventilation

Each working section is ventilated with a minimum of 9,000 cubic feet per minute of air at the last open crosscut. This air must not contain less than 19.5 percent of oxygen and not more than 0.5 percent of carbon dioxide. At least 3,000 cubic feet per minute must reach each working face where coal is being mined.

While a panel is being developed, all air going to the section (except air used to ventilate the haulage entry) is directed to the face by means of curtains across entries, line curtains, or auxiliary fans. This air is then directed to the section return, to the main return, and then to the outside. The air used to ventilate the haulage entry is curtained off outby the loading point and is vented directly into the section return. While rooms are driven and pillars extracted, air going to the section is usually split at the active pillar, with some going to the section return and the remainder flowing across the gob to the bleeder system.

Curtains

Check Curtains

Check curtains stop the airflow and direct it in a different direction. They also serve as temporary regulators. Burlap or plastic curtains are

placed across entries, or crosscuts, to help direct the flow of air to the face for ventilation purposes or prevent air from flowing into the gob. Special care must be taken when equipment is moved through check curtains to prevent tearing the curtains down and interrupting the ventilating air current. If a curtain is accidentally torn down, it should be replaced immediately.

Fly Curtains

Fly curtains serve the same purpose as check curtains but are installed in individual panels so that shuttle cars or other equipment can drive through without pulling the curtain down. To install fly curtains, boards are bolted across the top of the entry or crosscut and the curtain panel is securely nailed to the board.

Face Curtains

A face curtain is hung to direct air into a face that has advanced beyond the last open crosscut. These curtains are used primarily to keep the face area free of gas accumulations. Face curtains must be maintained within 10 feet of active working faces.

Auxiliary Fans

Blower Fans

Blower fans must be permissible and are to be maintained in this condition. This type of fan is installed in intake air. The volume of the intake air should be 2-1/2 times the manufacturer's rated capacity of the fan. The fan should be positioned at least 16 feet outby the nearest corner of the place to be ventilated and on the intake air side. The tubing must be capable of delivering at least 3,000 cubic feet per minute of air to each face. A blower fan can ventilate two faces simultaneously by using a Y-joint in the tubing.

Rock dust or a suitable fire extinguisher must be kept on the intake air side of the blower fan. A rubber mat should be kept under the blower fan so a person can stand on it while turning the blower on and off and be protected against electrical shock. The cable from the transformer to the fan must be hung from the mine roof and must not be allowed to touch the roof or rib.

The fan and tubing should be checked by the section foreman at the beginning of each shift for correct operation. To check for the proper volume of air passing over the fan, air readings should be taken every 2 hours during the shift and recorded in a record book maintained on the blower fan.

Exhaust Fans

Using an exhaust fan safely and effectively can greatly cut down on the amount of dust in the mine atmosphere. This not only reduces the amount of respirable dust but increases visibility and cuts down on explosive float dust in the work area. It also helps remove methane gas from the face area into the return airway.

Exhaust fans pull the dust and gas from the working face area through plastic or fiberglass tubing. The dust is then discharged into the return air entry. Care must be taken in hanging the tubing so that as few leaks as possible are in the tubing. The tubing should be maintained no farther than 10 feet from the working face at all times. The tubing should always be hung on the left side of the continuous miner for maximum effectiveness.

Some considerations when using exhaust fans include--

1. Positioning the exhaust fan where it will discharge into the return air.

2. Hanging all of the exhaust fan power cable from the roof and placing a rubber mat at the control switch.

3. Hanging the exhaust tubing on the left side of the continuous miner no more than 10 feet away from the working face area.

Panel Stopping

Panel stoppings are installed to direct air to the active areas of a working section. Stoppings are placed in crosscuts throughout the length of the panel to separate intake air, return air, and the haulageway.

Stoppings are of concrete block construction (solid or hollow blocks). A stopping can be constructed with mortared joints (wet) or can be built by stacking concrete blocks and later spraying with a sealing coating or covering with mortar on the pressure side.

In designing stoppings, the construction time gained by using dry construction must be weighed against losses in stopping strength and increased leakage. Stoppings must be maintained to separate intake and return airways to within two crosscuts of the face or active pillar line.

Planning for and Moving Supplies on Section

To ensure that needed supplies are at the proper location at the proper time, two conditions must be met. First, information concerning the supply need must be available and properly communicated. Second, the supplies themselves must be handled in a manner that will place them in the needed location at the right time. An information system and a material-handling procedure will be discussed in the material that follows.

Information System

Overview

The information system related to supply handling includes many areas that are not directly related to the section's operation or under the control of the section foreman. Some of these areas include the material replenishment activity, yard storage locations, and vendor delivery schedules. This discussion will be limited to the information required directly to accomplish the loading and scheduling of cars for section usage.

The most important information related to planning for and moving supplies on section is what supplies are needed, where, and when. This information is properly determined at the section level and transmitted to the supply yard for proper response.

Information Flow

Supply requirements for operations at the face and support activities are determined by the section foreman. A forecast system based on past experience or a demand system based on the day's needs can be used to provide supplies. With the former, considerable variance from a forecast is normal due to unexpected equipment downtime and geological variability. Information on the exceptions to forecasted requirements or a full day's requirements must be communicated from the section to the supply yard.

A typical information flow activity would begin with the section foreman, who determines requirements based on the rate of mining, geological characteristics encountered, and other factors. Requirements are communicated to a supply foreman, who lists the requirements by shift and section. No approval should be required for routine production supplies. The list is forwarded to supply-handling supervisors, who, in turn, direct the loading of goods onto supply cars and their delivery. To close the information loop, it is suggested that the section foreman routinely acknowledge receipt of the requested supplies rather than respond on an exception basis when he observes shortages. Special or emergency requests should go directly to the supply yard to avoid unnecessary delay.

Material Handling

Overview

Retreat mining supply requirements are different from those of advance mining, not only in terms of quantity and type (for example, a greater number of posts are consumed per ton of coal produced) but also because considerable losses result from supplies being left in the gob area and the trip distance is continually shortened rather than lengthened. A system using a standard supply load based on forecast requirements appears to offer the best answer to section supply handling problems. For this system, supply usage is forecast, and each day, a car containing the maximum number of supplies for a day is pulled to the section. The car from the previous day is recovered, with unused supplies remaining on the car. These are taken outside and returned to stores. The primary advantage of the standard car supply system is the elimination of double handling, reduction in track-side clutter, and a tendency to reduce supply waste. Some disadvantages of this system are the need for more cars, need for parking space on the section, and extra car shifting.

Supply Materials

Generally, there are four broad categories of supplies required on section:

Production Items.--These items are associated with the face operation and are generally considered to be expendable. Examples are posts, wedges, crib blocks, roof bolts and plates, rock dust, and brattice.

Support Items.--These items are all other nonequipment goods used on section in support of production. Examples are rail, ties, trolley wire, trolley feeder cable, pipe, and hand tools such as shovels, saws, and hammers. Some production items fall into this category.

Equipment Maintenance Items.--These items are generally broken into two categories, expendable and nonexpendable. Examples of expendable items are miner bits, roof bolter bits, and other cutting tools that may be used on section. Examples of nonexpendable items are all spare parts, cables, pipe fittings, nuts and bolts, hydraulic and air hoses, oxygen, acetylene, and tools.

Lubricants.--These items include all lubricating oils, greases, and hydraulic oils used to maintain equipment.

Material Flow

In a standard car supply system, the typical material flow cycle begins with a forecast requirement for each section. One standard car, for example, would always contain a specific quantity of posts and a specific quantity of wedges. Another would always be loaded with a specific quantity of crib blocks, roof bolts, and plates, while another car might contain a given quantity of rock dust bags. Another car would contain equipment maintenance items, parts, and brattice. A separate car would be used for lubricants. These cars would be loaded in the supply yard and arranged by section within the supply trip train. The arrangements of these cars within the section should always place the timber cars so that they end up close to their point of transfer. Arrangement of the various sections' supply cars within the trip is based upon the desired sequence of materials to be dropped off.

When the trip arrives at the specific section, the cars are parked as close to the face as is appropriate for that particular section. During the day, supplies are removed from the cars as they are used. By doing this properly, double handling is virtually eliminated. Typically, supplies are transferred to scoops or shuttle cars for movement to the immediate vicinity of their ultimate usage. This supply handling should be done when the miner is nonproductive, such as during place changes or servicing periods. Unused supplies remain on the cars and are returned to the supply yard. The unused supplies will become the base for the next set of standard cars. Recovered supply items such as rail or trolley wire are loaded onto the cars for return to supply storage. These recovered items are prepared for loading as they are recovered but are not loaded until immediately prior to removing the empty cars to the supply yard. Rails (except very short sections) require special cars that would be used for supplies on a scheduled periodic basis based on the rate of retreat.

Whether it is better to remove the empties before delivering the loaded cars is a matter for careful consideration. Some factors affecting this decision are as follows:

1. Time for removing empties and delivering fulls versus shifting cars and/or rearranging the supply trip at the section.

2. Availability of cars.

3. Sufficient parking space on the section.

4. Traffic conditions.

Other systems of supply handling exist, but all suffer from decided disadvantages, particularly double handling. The standard car supply system concept keeps the supplies mobile, to be advanced or retreated as the section moves. This capability can greatly improve supply handling at a minimal cost.

Forecasting Supplies

Forecasting is simple, based mostly on common sense. The following hypothetical example is given for descriptive purposes. It should be used as a learning tool and not for direct quantitative application.

Assumed conditions

High-grade coal
Low methane emission
Belt haulage
Rail supply system
Three-shift operation
6-foot seam
315 tons per shift production
18-foot-wide entries and splits
36-foot-square pillars
One pillar per shift
32 roof bolts per pillar split
93 posts per pillar
Nine bags of rock dust per pillar (one bag per 4 feet of split)

The split and fender pillar extraction process is assumed, using the plan given in figure 107.

Estimating a day's requirements

Item	Calculation	Minimum quantity per day
Coal production (tons)	315 x 3	975 tons
Pillars (blocks)	1 x 3	3 pillar blocks
Roof bolts	32 x 3	96 bolts
Bolt plates	32 x 3	96 plates
Posts	93 x 1 x 3	277 posts
Wedges	93 x 2 x 1 x 3	544 wedges
Rock dust	9 x 1 x 3	27 bags

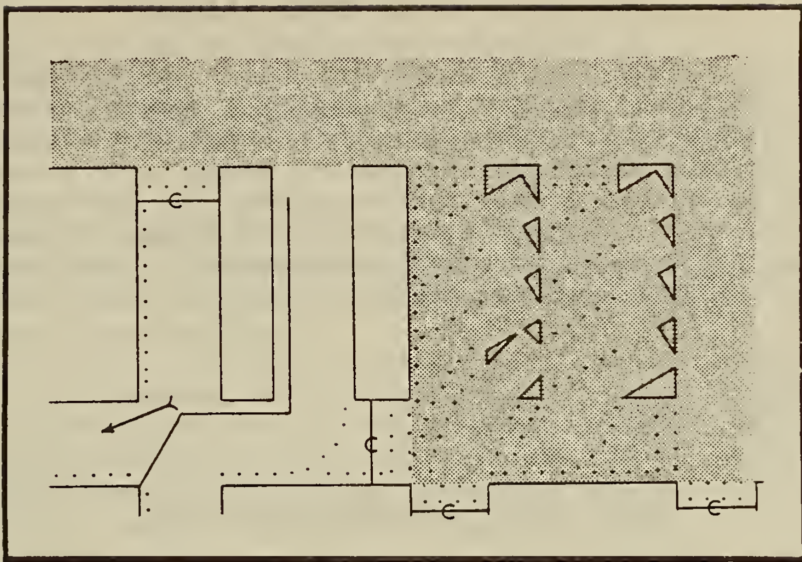


FIGURE 107. - Split-and-fender extraction plan for supply forecasting.

The additive shortage factor related to the items listed above should be based on the individual item rather than on the group as a whole. As a starting point, one might add 10 percent to 15 percent per item. This number could then be rounded off to the nearest full quantity unit load as purchased or stored. Maintaining extra supplies to allow for peak production is desirable, since without the proper number of supplies, production is curtailed. Although goods not used will automatically be recycled, it is best not to recycle too many items because this causes problems in loading operations. Determination of the shortage factor should be based on constant monitoring of usage and prevailing conditions.

Summary

The standard car supply system is held to be the best approach to minimizing supply-handling problems, but it is not always applicable in the purest form. A simple, day-to-day, reaction-to-demand system may be more effective; it uses the fewest supply cars, track, and switching of any system. However, it also requires the maximum amount of double handling. In planning for and moving supplies on section, the best solution for a specific mine may be a combination of the two supply-handling systems.

Chapter 8. THE EFFECTS OF THE COAL MINE HEALTH AND SAFETY ACT ON RETREAT MINING

The exact impact that the 1969 Coal Mine Health and Safety (CMH&S) Act has had on the ability to practice room-and-pillar retreat mining in the United States is impossible to determine, but it has been significant. Effects of the Surface Mining Act have not yet begun to be evaluated, but that there will be effects is a virtual certainty. In this chapter, a discussion of the areas of Chapter 30 of the Code of Federal Regulations as of 1979 that affect pillar extraction will be presented. The discussions will be divided into the following four topical areas:

1. Roof control and ventilation plans
2. Roof support
3. Ventilation
4. Electricity

Roof Control and Ventilation Plans

One of the requirements placed on mines performing retreat mining by the CMH&S Act concerns the formulation and improvement of roof control and ventilation plans. These plans are submitted to and approved by the District Manager of the applicable Mine Safety and Health Administration (MSHA) District. Plans are reviewed every 6 months and must include a pillar recovery plan and ventilation plan of pillared areas for those mines practicing pillar recovery. Statements of the specific requirements of these plans can be found in the roof support and ventilation discussions in this chapter.

The pillar recovery plan generally shows the sequence of cuts for the recovery of individual pillars and the sequence of pillar removal in a panel. The pillar recovery sequence normally shows the placement and sequence of roof support used during pillar extraction. In formulating pillar recovery plans, the mine operator should discuss proposals with the MSHA District roof control specialist. The specialist will frequently be able to suggest techniques that have worked for other mines under similar conditions, and at the very least, input during the initiation process will ease the approval process of the plan during the later stages. The ventilation (methane and dust control) plan shows the type and location of mechanical ventilation equipment and the details of the bleeder system. Once again, closely working with the MSHA District officials is important. State laws differ from Federal laws and must also be considered but will not be discussed in this report.

Roof Support

Roof support during pillar recovery is most heavily influenced by the CMH&S Act. The bulk of the regulations dealing with pillar recovery are expressed in Section 75.200-11, which is quoted below in its entirety.

s75.200-11. Criteria--Pillar Recovery Plan

Any reduction in pillar size during second mining shall be considered pillar recovery. Second mining is construed to be intentional retreat mining. The following criteria are applicable to pillar recovery roof control plans:

(a) Section s75.200-7, s75.200-8, and s75.200-9 should apply depending on whether the pillar recovery plan calls for conventional support or a combination of conventional support and roof bolting.

(b) During development, the size and shape of the pillars should be dictated by the depth of cover, height of coal, and other conditions associated with the coalbed. The smallest dimension of the pillar should be not less than 20 feet.

(c) Pillar splits and lifts should not exceed 20 feet in width.

(d) A minimum of two rows of breaker posts or the equivalent should be installed on not more than 4-foot centers across each opening leading into pillared areas and such posts should be installed before production is started. Such posts should be installed near the breakline between the lift being started and the gob.

(e) A row of roadside-radius (turn) posts or the equivalent should be installed on not more than 4-foot centers leading into pillar splits, including secondary splits in slabs, wings, or fenders.

(f) The width of the roadway leading from the solid pillars to a final stump (pushout) should not exceed 14 feet. At least two rows of posts or their equivalent should be set on each side of the roadway on not more than 4-foot centers. Only one open roadway leading to a final stump (pushout) should be permitted.

(g) Before full pillar recovery is begun in areas where roof bolts were used as the sole means of roof support and openings are more than 16 feet wide, supplementary support should be installed. Supplementary supports should consist of at least one row of posts installed on either side on not more than 4-foot centers lengthwise and limit the width of all roadways to 16 feet. These supports should be extended from the entrance to the split for at least one full pillar outby the pillar in which the split is being made.

(h) The following criteria should apply to open end pillaring:

(1) At least two rows of breaker posts or their equivalent should be installed between the lift being started and the gob on not more than 4-foot centers before the initial cut is made and should be extended to within 7 feet of the face. The width of the roadway should not exceed 14 feet.

(2) If the roof in open end pillaring has a tendency to hang, falls should be made, or cribs installed in addition to the breakline posts between the active lift and the hanging area. The cribs should be set not more than 8 feet apart. Heavy duty hydraulic jacks set at centers close enough to give equivalent support may be substituted for cribs, if such jacks are removed remotely.

Other provisions that affect pillar recovery techniques directly are quoted in the following material from sections s75.201, s75.201-1, and s75.201-2.

s75.201. Mining Methods (Statutory Provisions)

The method of mining followed in any coal mine shall not expose the miner to unusual dangers from roof falls caused by excessive widths of rooms and entries or faulty pillar recovery methods.

s75.201-1. Widths of Openings

(a) The method of mining shall provide widths of openings and pillar dimensions compatible with effective roof control. These widths and dimensions shall be incorporated into the roof control plan submitted for approval.

(b) Where excessive widths result from poor mining practices, additional roof support shall be installed before any travel or other work is done in such area. If excessive widths of openings are a result of coal sloughing, additional support shall be installed and the mining system reevaluated to determine changes that are necessary to minimize such occurrences.

s75.201-2. Pillar Recovery Methods

In addition to those criteria set forth in s75.200-11 which may be required in the roof control plan, the following shall apply to pillar recovery.

(a) The overall pillar recovery system shall be designed to minimize the possibility of outbursts or squeezes. The manner and sequence of recovery shall be included in the roof control plan submitted for approval.

(b) Where full pillar recovery is being done, extraction shall be such as to allow total caving of the main roof in the pillared area.

(c) During partial pillar recovery sufficient coal shall be left in place to support the main roof to the extent that the possibility of undue forces overriding the working places will be minimized.

(d) A combination of full and partial pillar recovery shall not be conducted on the same pillar line.

(e) If full extraction of pillars is being done and physical conditions such as standing water, adverse roof conditions, and falls of roof, or law requirements concerning oil and gas wells or surface subsidence dictate that some pillars of coal are to be left in place, a sufficient amount of coal shall be left to support the main roof so as to minimize the possibility of undue forces overriding the working places.

(f) Where full recovery of pillars is planned, the design of the pillars shall be compatible with the planned method of extraction.

(g) Pillaring methods shall eliminate pillar points and pillars that project inby the breakline.

(h) When recovering adjacent pillars left and right from the same opening, mining shall be completed in one such pillar lift and the openings posted off with at least two rows of breaker posts on not more than 4-foot centers before operations are started in the second pillar.

It should be emphasized that the roof support required in any particular mine is heavily dependent on the MSHA District Office. The officials at the district office will be relying heavily on their past experiences with other mines operating under similar conditions. If individuals at a particular mine desire to try methods that have not been proven in that area, they may encounter stiff resistance. In such cases, it is best to have as much analytic support for the methods to be tried as can be obtained.

Ventilation

Major changes have taken place in the ventilation patterns of most mines practicing pillar recovery since the CMH&S Act came into effect. The basic ventilation requirements are expressed in paragraph 75.301 and apply to both advance and retreat operations.

s75.301. Air Quality, Quantity, and Velocity

All active workings shall be ventilated by a current of air containing not less than 19.5 volume per centum of oxygen, not more than 0.5 volume per centum of carbon dioxide, and no harmful quantities of other noxious or poisonous gases; and the volume and velocity of the current of air shall be sufficient to dilute, render harmless, and to carry away, flammable, explosive, noxious, and harmful gases, and dust, and smoke and explosive fumes. The minimum quantity of air reaching the last open crosscut in any pair or set of developing entries and the last open crosscut in any pair or set or rooms shall be 9,000 cubic feet a minute, and the minimum quantity of air reaching the intake end of a pillar line shall be 9,000 cubic feet a minute. The minimum quantity of air in any coal mine reaching each working face shall be 3,000 cubic feet a minute. The authorized representative of the Secretary may require in any coal mine a greater quantity and velocity of air when he finds it necessary to protect the health or safety of miners. In robbing areas of anthracite mines, where the air currents cannot be controlled and measurements of the air cannot be obtained, the air shall have perceptible movement.

Details of air measurement locations are further delineated in paragraph 75.301-3.

s75.301-3. Locations of Air Measurements

The locations at which the quantity of air shall be measured are as follows:

(a) When a single split of air is used the volume of air shall be measured at the last open crosscut in a pair or set of developing entries or the last open crosscut in any pair or set of rooms which shall be the last crosscut through the line of pillars that separates the intake and return air courses. When the split system of ventilation is used, the volume of air shall be measured in the last open crosscut through the line of pillars that separates the intake and return air courses of each split.

(b) The volume of air at the intake end of a pillar line ventilated by a single split of air, shall be measured in the intake entry furthest from the return air courses and immediately outby the first open crosscut outby the line of pillars being mined. When a split system of ventilation is used, the volume of air shall be measured inby the last intake air split point.

(c) When longwall mining is practiced, the volume of air shall be measured in the intake entry or entries at

the intake end of the longwall face and the longwall shall be constructed as a pillar line.

(d) The volume of air reaching each working face shall be measured at the inby end of the line brattice or other approved device.

The bleeder systems requirements are expressed in paragraphs (e), (f), (g), and (i) of s75.316-2 and in s75.329.

s75.316-2. Criteria for Approval of Ventilation System and Methane and Dust Control Plan

(e) Bleeder entries, bleeder systems or equivalent means should be used in all active pillaring areas to ventilate the mined areas from which the pillars have been wholly or partially extracted, so as to control the methane content in such areas. Bleeder entries or bleeder systems established after June 28, 1970, should conform with the requirements of this s75.316-2.

(1) Bleeder entries shall be defined as special aircourses developed and maintained as part of the mine ventilation system and designed to continuously move air-methane mixtures from the gob, away from active workings and deliver such mixtures to the mine return aircourses. Bleeder entries should be connected to those areas from which pillars have been wholly or partially extracted at strategic locations in such a way to control airflow through such gob area, to induce drainage of gob gas from all portions of such gob areas and to minimize the hazard from expansion of gob gases due to atmospheric pressure change.

(2) Bleeder systems shall include any combination of bleeder entries, bleeder entry connections to any area from which pillars are wholly or partially extracted and all associated ventilation control devices. Such systems should extend from active pillar line of such gob to the intersection of that bleeder split with any other split of air, and shall not include active workings.

(f) (1) Bleeder entries developed after June 28, 1970 should be adequately maintained and free of water to permit safe travel or, if such bleeder entries cannot be traveled without exposing the mine examiner to undue hazard, such bleeder system should be designed and maintained so that bleeder entry performance can be evaluated for adequacy and continuity by a means approved by the Coal Mine Safety District Manager.

(2) When the mine operator deems that safe examination can be made such examination should be made at least once each week by a certified person designated by the operator to do so and the results of such examinations shall be recorded in a book as prescribed in s75.305. The certified person shall place his initials, the time and date at as many locations in the bleeder entries as are necessary to indicate that the entire length has been examined.

(3) When bleeder entry travel is considered unsafe, the evaluation of bleeder entry performance should be adequate to indicate that the bleeder system is functioning as specified in s75.316-3(e)(1) and shall be made at least once each week by a certified person or persons and the results shall be recorded in a book as prescribed in s75.305. To protect the safety of the miners when bleeder entry performance evaluation requires altering the normal airflow through the affected area, such evaluation should be made during idle shifts with power cut off from the affected area. Due precaution should be taken so as not to endanger any other area of the mine and suitable examinations for methane should be made at the edges of the pillar and such other places as may be required.

(g) The ventilation pressure differential between the active pillar line and the junction of any bleeder connection to the bleeder entries of such system should at all times be adequate to ensure gob gas drainage to the bleeder entries. The pressure differential shall be considered adequate when perceptible airflow exists in all open or regulated bleeder connections, as determined with chemical smoke or other approved means.

(h) The methane content of the air current in the bleeder split at the point where such split enters any other air split should not exceed 2.0 volume per centum.

(i) When the return aircourses from all or part of the bleeder entries of a gob area and air other than that used to ventilate the gob area is passing through the return aircourses, the bleeder connectors between the return aircourses and the gob shall be considered as bleeder entries and the concentration of methane should not exceed 2.0 volume per centum at the intersection of the bleeder connectors and the return aircourses.

s75.329. Bleeder Systems

On or before December 30, 1970, all areas from which pillars have been wholly or partially extracted and

abandoned areas as determined by the Secretary or his authorized representative, shall be ventilated by bleeder entries or by bleeder systems or equivalent means, or be sealed, as determined by the Secretary or his authorized representative. When ventilation of such areas is required, such ventilation shall be maintained so as continuously to dilute, render harmless, and carry away methane and other explosive gases within such areas and to protect the active workings of the mine from the hazards of such methane and other explosive gases. Air coursed through underground areas from which pillars have been wholly or partially extracted which enters another split of air shall not contain more than 2.0 volume per centum of methane, when tested at the point it enters such other split. When sealing is required, such seals shall be made in an approved manner so as to isolate with explosion-proof bulkheads such areas from the active workings of the mine.

s75.329-1. Sealing or Ventilation of Pillared or Abandoned Area

(a) All areas of a coal mine from which the pillars have been wholly or partially extracted and abandoned areas shall be ventilated or sealed by December 30, 1970. For those coal mines in which ventilation can be maintained so as to continuously dilute, render harmless and carry away methane and other explosive gases within such areas and to protect the active workings of the mine from hazards of such methane and other explosive gases, the operator shall request permission from the Coal Mine Safety District Manager in whose district the mine is located to ventilate such areas.

(b) The request for permission to ventilate such areas must be submitted in time to allow consideration of the request, to obtain approval, and to permit the operator to install the ventilation system, or to install seals in the event the request to ventilate is denied, on or before December 30, 1970.

(c) The determination of whether ventilation will be permitted will be made after taking into consideration the history of methane and other explosive gases in the mine, the size of the gob or abandoned areas, and if the areas can be ventilated adequately.

(d) To be considered for approval the request shall contain the following information provided by the mine operator.

(1) Name of mine and company.
(2) Location of mine (town, county, state).
(3) Operator's name and address.
(4) Date of application.
(5) A detailed history of the methane content determined throughout the mine and when available, the volume of air in which such methane determinations were made, to support the operator's application to ventilate.

(e) A description of the method by which the areas from which the pillars have been wholly or partially extracted and abandoned areas shall be ventilated and such maps and drawings as may be required to illustrate such method and to indicate existing or proposed air volumes used to ventilate such areas.

(f) The signature and title of the person who submits the application for the operator.

An extensive discussion of bleeder systems was presented in Chapter 6, Mine Planning and Retreat Mining, and will not be repeated. However, it should be emphasized in the context of the effects of the law on retreat mining that the establishment and maintenance of bleeder systems is of primary importance to the operation and success of pillar recovery. It must also be stated that in some cases, the difficulty involved in establishing and maintaining bleeder systems and their impact in the amount of recoverable reserves has been a deciding factor in a mine's decision to practice retreat mining. The extent of the bleeder systems required will depend on the gas liberation levels and various mining conditions such as roof type and tightness of fall. The best indication of requirements for the bleeder system will normally be found in observing operations in the other mines operating in the area. In areas where spontaneous combustion is a problem, it is frequently more desirable to seal pillared areas than to attempt to bleed them.

Other than the effects felt due to bleeder systems, ventilation requirements unique to retreat mining have not been extensive. Of course, the coal dust and gas level requirements must be complied with as they were on advance. However, on retreat, most of the gas has already bled off and coal dust is generally less significant compared with the conditions experienced on advance.

Electricity

The vast majority of regulations governing the conditions of electricity use in coal mines do not affect retreat mining per se. One paragraph, s75.1002, limits the placement of trolley wires, trolley feeder wires, and high voltage cables to locations at least 150 feet away from pillar workings.

s75.1002. Location of Trolley Wires, Trolley Feeder Wires, High-Voltage Cables and Transformers

Trolley wires and trolley feeder wires, high-voltage cables and transformers shall not be located inby the last open crosscut and shall be kept at least 150 feet from pillar workings.

s75.1002-1. Location of Other Electric Equipment; Requirements for Permissibility

(a) Electric equipment other than trolley wires, trolley feeder wires, high-voltage cables, and transformers shall be permissible, and maintained in a permissible condition when such electric equipment is located within 150 feet from pillar workings, except as provided in paragraphs (b) and (c) of this section.

(b) Notwithstanding the provisions of paragraph (a) of this section, in any coal mine where nonpermissible electric face equipment may be taken into or used inby the last open crosscut until March 30, 1974, such nonpermissible electric face equipment may be located within 150 feet from pillar workings.

(c) Notwithstanding the provision of paragraph (a) of this section, in any coal mine where a permit for noncompliance is in effect, nonpermissible electric face equipment specified in such permit for noncompliance may be located within 150 feet from pillar workings for the duration of such permit.

Chapter 9. DEVELOPING A SECTION FOREMAN'S GUIDEBOOK

Introduction

Each mine operates in a somewhat different environment, geotechnically and organizationally, than other mines in the same general area. Because of this fact, it is highly unlikely that a comprehensive, all-encompassing guidebook for section foremen could be developed for general application. Rather, each company should design its own guidebook, to address specifically the operations and conditions of its particular mines. Increasingly, individual companies are developing their own guidebooks for foremen. Many were encountered during this study--varying in quality but all successful in their applicaton. It is the purpose of this section to present a method for the development and use of mine-specific section foreman guidebooks. This method can be used for developing handbooks for engineering groups or other technical persons.

Purpose of Guidebooks

Guidebooks should serve as reference sources for foremen, giving pertinent information concerning the mining method used on the section involved. They should not be used as a substitute for proper training or for direct interaction and communication with mine management. They should not supersede or conflict with any existing State or Federal mining laws. Further, they should not supersede approved mining projection maps at any time with regard to room depths or crosscut locations.

Proper use of guidebooks allows for some standardization in an extremely variable environment. The ultimate objective of such standardization is safer mining practices and increased productivity. With this objective comes cost efficiencies in terms of time and materials and, of course, increased output.

Introducing the Guidebook Concept to Foremen

The first and by far the most important step in the creation of a guidebook is to introduce the guidebook concept. The concept must have the support of the intended user or it will not be used.

It is highly recommended that guidebook users be involved in its preparation and be trained in guidebook usage. Some ways of achieving these objectives include--

1. Involving foremen at the beginning in the actual design and structuring of the guidebook.

2. Requesting comments and suggestions from a panel of foremen reviewing the draft guidebook.

3. Conducting seminars or workshops that present simulated problems and require the guidebook as a reference source to solve the problems.

4. Using the guidebook as a training tool and part of formal aboveground classroom training.

The key is involvement. Foremen who participate in the development of a guidebook will feel a commitment to the final product. Under these conditions the guidebook is more likely to be accepted and used if its presence is not viewed as an upper management directive but rather as a foreman's guidebook developed by foremen. Acknowledgments that specifically identify participants and contributors can be a very positive gesture toward achieving this commitment.

A final point to be made is that completely successful implementation of a guidebook will require an introductory an training program that requires the foremen to use the book. One suggested approach is to tie the introduction and formal training of guidebook use to the formal training at the mine. This approach may be least disruptive and will integrate well with other training topics routinely covered during foreman training sessions.

Developing the Guidebook Outline

A topical outline for the guidebook should be developed to assist in the organization and writing of the guidebook. This simple but often neglected exercise can save an immense amount of time and money and ensure that all important topics are covered in the guidebook. The level of detail in an outline should be sufficient to identify specific task areas for easy reference. The outline is essentially a table of contents of the guidebook; an example of parts of a retreat mining guidebook to which foremen can refer follows.

Example Outline: Foreman's Retreat Mining Guidebook

I. General information

II. Sequence of mining and entry and room dimensions

- A. Panel development
- B. Bleeder connections
- C. Room development
- D. Room-and-pillar recovery
- E. Chain pillar recovery

III. Equipment operation

- A. Continuous miner
    - 1. Pre-shift safety inspections and servicing
        - a. Checking power and cable
        - b. Inspecting the continuous miner
        - c. Energizing the continuous miner
        - d. Inspection of work place
        - e. Routine maintenance
    - 2. Continuous miner operations

a. Tramming the miner on retreat sections
b. Setting temporary supports in each place

B. Roof bolts

IV. Belt moves and placement

V. Free cuts and posting

VI. Ventilation

VII. Haulage

VIII. The effects of the Coal Mine Health and Safety Act on retreat mining

A. Roof control and ventilation plans

B. Roof support

1. s75.200-11. Criteria--Pillar Recovery Plan
2. s75.201-2. Pillar Recovery Methods

C. Ventilation

1. s75.301. Air Quality, Quantity, and Velocity
2. s75.301-3. Locations of Air Measurements
3. s75.329. Bleeder Systems
4. s75.329-1. Sealing on Ventilation of Pillared or Abandoned Area

D. Electricity

1. s75.1002. Location of Trolley Wires, Trolley Feeder Wires, High-Voltage Cables and Transformers

2. s75.1002-1. Location of Other Electric Equipment; Requirements for Permissibility

Although this guidebook outline focuses on retreat mining operations, a foreman's handbook should cover all aspects of panel mining, including both development and retreat work.

Selecting the Format of the Guidebook

Guidebooks should be clearly and concisely written and organized in such a way as to make them easily usable. A format that allows for rapid and easy identification of relevant topics is essential as well. Again, the purpose of a guidebook is ready reference, so rapid access to topical areas of interest is a major factor in guidebook design.

Another consideration in format selection is the physical structure and appearance of the guidebook. Innumerable options are available. For

example, sizes can vary from pocket size to even larger than the standard 8-1/2 by 11-inch reproducible bond. The guidebook may be produced in a bound form (hard or soft cover) or in some form of loose leaf notebook. In this latter format, individual sections can be taken from the main body and used as necessary.

Assembling the Information

In preparing a guidebook, it is important to be detailed and comprehensive. Therefore, complete information on each topic to be covered in the guidebook is a must. Collecting the information from those in the company most familiar with each topic is probably the most cost effective and timely approach. For example, information related to panel and section dimensions is best obtained from the engineering group; labor relations data are best obtained from the personnel department. Of course, regulations can usually be obtained from several in-house sources or directly from regulating agencies.

Improving and Updating the Guidebook

Probably the greatest problem in gaining acceptance and routine use of guidebooks over the long term is that they become outdated. Regulations change, mining conditions change, labor relations change, equipment changes, and mining techniques change. Thus, ongoing guidebook maintenance is just as important as routine continuous miner maintenance.

The necessity of improvements and updates, more than any other, requires a guidebook format that can be updated with new information. Reprinting entire guidebooks periodically is a much less effective means and would not get the new information disseminated nearly as rapidly as routine update sheets. With a loose leaf notebook format, old sheets can be discarded as new ones are issued. New and revised sheets should be so noted in a covering letter, and the date of issue of the revision should be indicated near the page number of the newly revised sheet. This ensures that the reader can determine if his copy contains the latest information.

Adler, L., and J. L. Gallimore. The Need for a New Mining System. Min. Cong. J., September 1972, pp. 24-29.

This article provides a general description of both the development and retreating phases of room-and-pillar mining. A cut sequence for wing and pocket pillaring and a pillaring sequence for mining rooms and a single row of blocks with a continuous miner are illustrated. However, because of the disadvantages of the room-and-pillar system, a retreat mining system combining the longwall and room-and-pillar methods is described and recommended.

Adler, H., S. W. Potts, and A. Walker. Mechanized Room-and-Pillar Mining: A General Appreciation of Developments in Great Britain. Trans. Inst. Min. Eng. (London), v. 110, 1950-51, pp. 728-740.

Available information from the coalfields regarding room-and-pillar work is summarized, and developments are described with respect to (1) normal development of previous practice and (2) recent adoption without reference to previous practice. Details are given of a representative selection of mechanized room-and-pillar installations considered to be giving the best results, and the lessons to be learned from the experience gained are stated.

Asman, A. W., and A. W. Bitner. Characteristics of Mechanized Mining Sections. Min. Eng., September 1951, pp. 803-804.

An analysis is made of three different types of section production units that represent the manner in which most of the Nation's bituminous coal is produced. The general delays and production characteristics of these sections are presented along with a method for evaluating section performance based on actual and theoretical production characteristics.

Bise, C. F., R. V. Ramani, and R. Stefanko. An Analysis of Underground Extraction Techniques for Thick Coal Seams. Coal Research Station, The Pennsylvania State University, University Park, SR-111, 1976, 209 pp.

This document provides a general description of thick-seam methods and a description of actual mining operations in North America. Several mining methods are recommended, including a room-and-pillar method. Safety factors are briefly discussed.

Bobo, B. L. Experience With Continuous Miners at Mathies. Min. Cong. J., July 1966, pp. 30-36.

This article describes the pocket-and-fender method of pillar extraction with continous miners used at the Mathies mine in Pennsylvania.

Campbell, J. A. L., L. J. Petrovic, W. J. Mallio, and C. W. Schulties. How to Predict Coal Mine Roof Conditions Before Mining. Min. Eng., October 1975, pp. 37-40.

Geological modeling, lineaments, and construction of a geologic model to predict roof conditions are discussed. The use of overlays are used to depict data graphically.

Canadian Mines Branch, Department of Energy, Mines and Resources, Proceedings of the 9th Canadian Rock Mechanics Symposium, Ottawa, Canada, 1974.

This document includes a statement of the Holland-Gaddy formula for coal pillar design, a review of the mine examination required with practical suggestions as to what to look for and how to do it, and a review of several pillar design formulas recently suggested and a comparison of each with the other as to results and procedures.

Cassidy, S. M. (ed.). Elements of Practical Coal Mining. Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., New York, 1973, 614 pp.

Ventilation and dust control, development mining, retreat mining methods, pillar lines, partial extraction, multiple-seam mining, and pitching seams are among the topics covered in this handbook.

Chauhan, N. P. Extraction of a Thick Seam in Chirimiri Coalfield Using Trolly Wire Locomotives. J. Mines Met. and Fuels, November 1971, pp. 335-339.

This article deals with the problem of extracting thick seams developed in the past, with some coal left in roof and floor. The method presented is to extract pillars by slicing with open goat, up to a height of 5.4 meters using trolley wire locomotives and mine cars right up to the stooks under extraction. The thickness of the seam varies from 6 to 9 meters, with past developments of 3 to 4 meters in height in the area under extraction. The gradient of the seams is nearly flat with a strong roof of massive sandstone.

Chironis, N. P. Peabody Mine's Serpentix Boosts Mining Output. Coal Age, April 1977, pp. 58-64.

This article describes the serpentix haulage system (a belt conveyor system suspended from monorail track attached to the roof by conventional roof bolts) used in a mine having a room-and-pillar mining plan.

Coal Age. Boosting Mining Efficiency. December 1955, pp. 50-55.

This article describes the mine conditions at the Buckhorn mine, Ill., the pillar recovery method used, and the roof support and roof coating systems applied.

_____. Bulk of US Underground Coal Production Still Issues from Room-and-Pillar Work. July 1976, pp. 110-113.

A six-entry room-and-pillar section using two miners and two bolters is described. Advantages include a substantial savings of tramming time and a reduction in abnormal delays in the cycle. Research on a continuous miner equipped with a bolter conveyor and remote control is also discussed.

_____. Continuous Mining. July 1971, pp. 160-164.

Continuous mining equipment and systems, including room-and-pillar mining, are discussed.

_____. Conventional Mining. July 1971, pp. 169-173.

Conventional mining is described with respect to equipment selection, conventional systems, and face preparation, including pillar lines and pillaring plans.

_____. Hanging Ventilation Curtains. November 1978, pp. 111-115.

This article describes a technique for hanging air curtains that permits them to be installed, moved, opened, and closed more easily than when they are nailed or spadded in place. The technique involves the use of low-leakage, low-cost plastic curtains threaded onto a steel cable that is suspended from roof bolt plates by S-shaped hooks. The outby end of the cable is reeled off a hand-operated winch; the inby end of the cable is anchored to a roof bolt plate by means of a cable grip and an S-shaped hook.

_____. High Tonnage With Small Crews. September 1956, pp. 60-63.

Open-end pillaring with a continuous miner at the Isabella mine, Pennsylvania, is described. Included in the discussion are roof support details, a two-pass mining system, and equipment used.

_____. Mining Guidebook. July 1972, pp. 130-158.

Mine development (i.e., initial planning, mine projections, and entry driving), continuous and conventional mining equipment and pillaring systems, roof control, haulage and hoisting, and ventilation fundamentals are among the topics covered in this guidebook.

_____. Mining Methods and Equipment. October 1970, pp. 100-133.

Mining methods, including pillar extraction, and equipment; roof control methods; and ventilation and drainage methods practiced by various mines are discussed. Problems encountered and solutions provided are included.

_____. More Powerful Continuous Miners. April 1962, pp. 72-75.

This article describes how more powerful and rugged continuous miners boost productivity. The pillaring, roof bolting, and ventilation plans for mining the Pittsburgh seam are also described.

_____. Pillar-Mining Team: Continuous Miner and Tracklaying Shuttle Car. July 1953, pp. 98-99.

The recovery of Pittsburgh seam pillars sandwiched between wet fire clay bottom and draw slate top is described. A system is developed using a continuous miner, a pickup loading machine, and a tracklaying shuttle car. Roof support work is also described.

_____. Pillaring With Continous Miners. October 1956, pp. 73-77.

This article describes various aspects of and methods of pillaring with continuous miners, for example: stepped pillar line, combination advance and retreat, full retreat, angle plans, conventional open ending, angle open ending, splitting plans, pocket-and-wing plans, and a basic room-and-pillar plan modified for an extensible-belt.

_____. Practical Ways to Cut Coal Mining Costs. Coal Age, New York, 1950, 224 pp.

This publication is a composite of articles published in Coal Age and organized under such headings as: mechanized coal mining; underground transportation; coal preparation; mine safety; and ventilation, drainage, and pumping.

_____. Preparing for Continuous Mining. May 1957, pp. 70-75.

This article defines the factors that need to be considered in developing a mining system using continuous miners. Topics covered include: machine type, panel layout, plan development sequence to achieve maximum operating time and minimum moves for mining machine, open-end pillaring, roof support, ventilation, and haulage.

_____. The Deep-Mining Guidebook. Mid-July 1958, pp. 34-57.

Retreat operation planning (including bleeders and pillar size and shape), entry driving, room plans, pillaring systems, pillar lines, and haulage are among the topics discussed in this guidebook.

Corwine, J. W. Review of Roof Control Technology Research. Min. Cong. J., January 1976, pp. 25-29.

Present ground and roof control research programs in the following areas are described: preliminary investigations, mine layout and opening design, selection and application of support systems, safe installation of supports, hazard detection, and mining systems for improved ground control.

Currie, R. D., and E. R. Maize. A Ventilation Study of the Graceton Coal & Coke Co. Mine, Graceton, PA. BuMines IC 6614, 1932, 10 pp.

Relevant topics covered in this article are doors, overcasts, and stoppings. Their construction and most effective usage are described.

Curth, E. A. Relative Pressure Changes in Coal Pillars During Extraction: A Progress Report. BuMines RI 6980, 1967, 20 pp.

This report describes the pillar extraction method used at the Nemacolin mine in Pennsylvania. Tests were conducted to determine the relative pressure changes in the coal pillars during extraction, and conclusions are presented.

Flint, J. D., and C. Taylor. Pillar Extraction With Conventional Trackless Mechanized Units. J. S. Afr. Inst. Min. and Met., September 1971, pp. 47-56.

A description is given of the pocket-and-fender method of pillar extraction of a coal seam varying in thickness from 10 to 14 feet. Conventional, trackless, mechanized units are used to extract the coal.

Gilley, J. L., and E. Thomas. Pillar Extraction With Roof Bolts. Min. Cong. J., November 1951, pp. 30-33.

The pillar recovery practices at a mine in southern West Virginia are described, and tables that compare the results of mining with conventional timbering to mining with roof bolting are included.

Given, I. A. (ed.). SME Mining Engineering Handbook. Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., New York, v. 1, 1973.

Rock mechanics and other factors involved in selecting a mining method, roof and ground control, underground haulage, ventilation, and underground mining systems and equipment are relevant topics covered in this handbook. With respect to room-and-pillar extraction methods, bleeders, complete versus partial extraction, cutting approaches, and economics are discussed.

Gooding, K. M. (comp.). Proceedings of the Symposium on Respirable Coal Mine Dust, Washington, D.C., November 3-4, 1969. BuMines IC 8458, 1970, 297 pp.

Pertinent papers in this document cover (1) ventilation theories and principles and (2) ventilation practices for dust control.

Green, L. E., and E. R. Palowitch. Comparative Shortwall and Room-and-Pillar Mining Costs. BuMines IC 8757, 1977, 20 pp.

This report describes the room-and-pillar mining method used at a Beth-Elkhorn mine in Kentucky--including the pillar extraction sequence--and makes an economic comparison between this method and a shortwall method used in an adjacent mine.

Grouch, S. L., and C. Fairhurst. The Mechanics of Coal Mine Bumps and the Interaction Between Coal Pillars, Mine Roof, and Floor. BuMines Open File Rept. 53-73, 1973, 88 pp.; available for references at Bureau of Mines facilities at Pittsburgh, Pa., Denver, Colo.; Spokane, Wash., and Twin Cities, Minn.; and at the Central Library, U.S. Department of the Interior, Washington, D.C.

This report describes the circumstances likely to be responsible for coal mine bumps. Studies predict that a large bump would be less likely in longwall mining. However, since this type of mining cannot always be carried out, a pillaring system that limits the amount of development prior to pillar extraction is recommended. Procedures for accomplishing this are provided.

Haley, W., J. J. Shields, A. L. Toenges, and L. A. Turnbull. Mechancial Mining in Some Bituminous Coal Mines. Progress Report 6. Extraction of Pillars With Mechanized Equipment. BuMines IC 7631, 1952, 64 pp.

General discussions on recovery in coal mining and roof action and control are followed by descriptions of mines and the mining and pillar extraction methods used by each.

Hazen, G., and L. Artler. Practical Coal Pillar Design Problem. Min. Cong. J., June 1976, pp. 86-92.

This article describes the tests conducted on coal pillars to determine their strength under stress. The higher stresses were found on the inside

of each pillar and the lower stresses fell to the outside. The general trend depicted was that the specimens became stronger as the became larger.

Herbert, C. A. Some Factors Affecting and Suggested Ways for Improving Coal Mine Ventilation, With Particular Reference to Mines in Illinois, Indiana, and Western Kentucky. BuMines IC 7656, 1953, 15 pp.

The causes of explosive methane accumulations in mines discussed are lack of well-maintained air courses; air losses due to leaky stoppings, trap doors, and overcasts; faulty mining methods; and poor supervision. A modified room-and-pillar mine development plan is suggested to eliminate many of the hazards of gas accumulations inherent in the present method of mine development.

Hess, W. E. Pillar Extraction in the Pittsburgh Seam With Continuous Miners. Min. Eng., February 1955, pp. 162-166.

This article describes the advantages of using the continuous miner instead of conventional mining in pillar extraction.

Hittman Associates, Inc. Underground Coal Mining: An Assessment of Technology. Electric Power Research Institute, Palo Alto, Calif., EPRI AF-219, July 1976.

This report includes two pertinent sections--Underground Coal Mining Today, and Interrelationship and Constraints in Underground Mining. Topics discussed in these sections include mine development, room-and-pillar mining systems, pillar sizes, loading and hauling, production variables, conventional and continuous mining equipment advantages and disadvantages, ground control, pillar stresses, roof support, ventilation, and mine drainage.

Hoard, C. M., and C. S. Cressman. Full Pillaring With the Boring-Type Miner. Coal Age, March 1959, pp. 74-78.

An increase in production at Mine No. 41 of the Bethlehem Mines Corp. in West Virginia is attributed to use of a boring-type miner for pillaring, adoption of slabbing as the pillar-extraction method, a change from a 45-degree to a flat pillar line (good illustration of the differences provided here), and the adoption of a rope-frame panel belt to cut delay time to the absolute minimum.

Holland, C. T. Factors in the Design of Barrier Pillars in Coal Mines. Proc. W. Va. Coal Min. Inst., Morgantown, W. Va., 1965, pp. 109-126.

This paper is confined to factors affecting the design of those pillars left in a coal mine to delimit the stress effects produced by mining operations.

_____. The Strength of Coal in Mine Pillars. Proc. 6th Symp. Rock Mech., Univ. Mo., Rolla, Mo., 1964.

Discussed in this article are experiments relating to pillar size and strength, a proposed coal pillar strength formula, and verification of the formula's reliability.

Holland, C. T., and F. L. Gaddy. Some Aspects of Permanent Support of Overburden of Coal Beds. Proc. W. Va. Coal Min. Inst., Morgantown, W. Va., 1956, pp. 43-65.

This paper discusses some of the factors involved in determining the amount of coal that should be left in a mine to provide permanent support for overburden.

J. J. Davis Associates. Study of Methods to Improve Pillar Extraction Practices in Underground Coal Mines: Part III, Rock Mechanics. Preliminary rept. prepared for BuMines under contract USBM H0242007, 1975, 111 pp.; available from J. J. Davis Associates, McLean, Va.

This preliminary report determines the principal factors contributing to high accident frequency and severity in both conventional and continuous mining operations. It also compares and evaluates the safety aspects of the open-end and split-and-fender systems of pillar mining. Basic data required to decide what constitutes an adequate pillaring plan that will optimize efficiency, recovery, and safety is established. Recommendations are made to improve existing pillaring methods and to ensure that proper techniques are implemented. Areas where additional studies or new research may be of value are suggested.

_____. Study of Methods to Improve Pillar Extraction Practices in Underground Coal Mines: Volume 1, Pillar Safety and Production Practices. J. J. Davis Associates, McLean, Va., 1975.

This report covers pillar extraction methods and practices and provides recommendations for improving pillar extraction. Also covered are rock mechanics of pillar extraction and accident analysis.

Johnstone, J. Recent Developments in Underground Mining in Australia. 3rd Symp. on Underground Mining. National Coal Association, Washington, D.C., 1977, pp. 9-24.

This paper describes bord or pillar mining in New South Wales and the Old Ben and Wongawilli systems of room and pillar mining.

Jones, D. C. Pillar Extraction With Continuous Mining Machines. Mechanization, December 1955, pp. 54-59.

This article describes the pillar extraction method used at the Lancashire No. 15 mine in Pennsylvania. Topics discussed include timbering, ventilation, safety, production, and continuous miners.

Kalasky, J. D., and S. Krickovic. Ventilation of Pillared Areas by Bleeder Entries, Bleeder Systems, or Equivalent Means. Trans. Soc. Min. Eng., AIME, v. 254, December 1973, pp. 284-290.

The fundamentals of effective bleeding for provision of good ventilation and control and removal of methane are described. The various mine pillaring systems for which it is both easy and difficult to provide effective bleeder systems are detailed.

Keenan, A. M. Pillar Extraction Methods Developed at Kenilworth. Mechanization, August 1949, pp. 50-59.

The successful extraction of pillars at the Kenilworth mine in Utah is described in great detail. Topics covered include mine conditions, mine layout, pillar extraction (including the advantages of a 45-degree line), roof support, machinery, haulage, and ventilation. The problem of spontaneous combustion of coal near the surface is dealt with.

Kharkar, R., R. V. Ramani, and R. Stefanko. Analysis of Leakage and Friction Factors in Coal Mine Ventilation Systems. Pennsylvania State University, University Park, Pennsylvania, SR-99, April 1974, 73 pp.

Relevant information contained in this document is a description of the coal mine ventilation systems in the United States.

Kingery, D. S. Introduction to Mine Ventilating Principles and Practices. BuMines Bull. 589, 1960, 54 pp.

This bulletin is written to explain in layman language the basic laws and fundamentals of mine air flow and their application to the solution of common ventilation problems.

Krisko, W. J. Evaluation of the Use of Air Curtains to Increase Face Ventilation. BuMines Open File Rept. 157-77, 1977, 126 pp.; available for reference at Bureau of Mines facilities at Denver, Colo., Twin Cities, Minn., Bruceton and Pittsburgh, Pa., Spokane, Wash.; Department of Energy facilities at Carbondale, Ill., and Morgantown, W. Va.; at the Central Library, U.S. Department of the Interior, Washington, D.C.; and from the National Technical Information Services, Springfield, Va., PB 274 324/AS.

Laboratory and in-mine tests were used to determine the feasibility of using an air curtain in place of brattice cloth to separate incoming air from exhaust air at the face of a room-and-pillar underground coal mining operation. Laboratory experiments proved that the concept of an air

curtain separating two parallel streams of air is valid. The in-mine tests consisted of measuring respirable dust concentrations at the operator's position both with and without the air curtain. These tests demonstrated that the installed air curtain could act as effectively or more effectively than line brattice in coursing air to the working face.

Laird, W. Pillar Extraction in High Coal. Mechanization, April 1963, pp. 31-21.

The pillar extraction method used at the Federal No. 1 mine in West Virginia is described.

Luxner, J. V. Face Ventilation in Underground Bituminous Coal Mines. Airflow and Methane Distribution Patterns in Immediate Face Area-Line Brattice. BuMines RI 7223, 1969, 16 pp.

The effectiveness of face ventilation by line brattice is reviewed with respect to the method of ventilation (i.e., blowing and exhausting), the face distance, the tight rib distance, the volume of air delivered to the end of the line brattice, and the volume of methane released at the face. Analysis of data are based upon the ability of a face ventilation system to dilute methane in the immediate face area.

Mason, R. H. Amherst Boosts Production 50% With Continuous Haulage System. Coal Min. and Proc., August 1977, pp. 52-57.

The continuous haulage system installed by Amherst Coal Co. utilizes conveyor belting in the bridge conveyors and mobile bridge carries. This system allows for 90 to 95 percent recovery on pillaring, and the entire pillar can be extracted without moving the haulage system.

_____. How a Small Operator Gets Big Productivity. Coal Min. and Proc., July 1978, pp. 66-71.

The Mason Coal Co. achieves high productivity with a continuous miner and continuous haulage system. A description of the room-and-pillar advance and retreat mining system used by the company is given.

National Coal Board. Memorandum on the Design of Mine Workings to Secure Effective Strata Control. Trans. Inst. Min. Eng. (London), v. 110, 1951, pp. 252-271.

This article sets out, in a very understandable fashion, guiding principles for the design of mine workings to reduce loads in the working area. It is suggested that concentrations of main roof load in working areas can be avoided by the controlled transference of load if proper provision is made for the accommodation of the concentrated abutment loads on coal pillars of adequate dimensions or in excavated areas in positions

clear of the roadways. The behavior of coal pillars is discussed and pillar dimensions are related to the widths of the adjoining excavations. The foregoing considerations are applied to, among others, the design of mechanized room-and-pillar workings.

Norris, W., Jr. Pillaring Operations With Continuous Mining Machines Under Bumping Conditions. Min. Cong. J., March 1960, pp. 41-43.

Bumping problems experienced at two mines in West Virginia and experiments toward a solution when mining pillars with continuous mining machines are discussed.

Palowitch, E. R. Underground Coal Mining Research. Min. Cong. J., February 1978, pp. 34-41.

The underground coal mining research and state of the art in 1977 is desribed with respect to mine planning, design and development, convention systems, room-and-pillar mining, advanced systems, and health and safety.

Parker, J. Practical Rock Mechanics for Miners, Parts 1 through 7. Eng. and Min. J., June through December, 1973, and January through February, 1974.

This series of articles describes simple, inexpensive, money-saving approaches to problem solving in the field of rock mechanics based on the built-in knowledge and experience of mine operators. Topics covered are surface subsidence; convergence measurements; relationship between structure, stress, and moisture; design of mine openings; roof support; and pillar design.

Peng, S. S. Coal Mine Ground Control. John Wiley & Sons, New York, 1978, 450 pp.

This document is to be used as a textbook on roof control of underground coal mine openings. It stresses the practical application of various techniques. In addition to discussions on topics such as coal pillars, room-and-pillar mining is covered specifically with respect to typical section layout, room or entry development, and pillar recovery.

Peng, S. S., and U. Chandra. Getting the Most From Multiple-Seam Reserves. Coal Min. and Processing, November 1980, pp. 78-84.

This article presents the results of a study of 20 West Virginia mining operations that deal with multiple seams. Information on mining problems encountered and the circumstances leading to those problems were obtained. The authors discuss five cases to illustrate how several typical ground control problems can be eliminated by the application of fundamental principles of ground control. Guidelines for multiple-seam mining are recommended.

R. J. Bowen Mining Engineering Consultants. Sublevel Caving by Pillar Extraction. U.S. Department of Energy, FE-9115-1, May 25, 1977, 160 pp.

This report describes the design and feasiblity analysis of the Sublevel Caving by Pillar Extraction mining method which is a conceptual mining method devised toward the objective of improving mining techniques for extraction of deep coal occurring in seams of thicknesses greater than 12 feet. The concept envisions that advance openings of the mine will be driven along the bottom of the thick seam with top coal being extracted incrementally during retreat mining, or in "falls," shot down from the roof. Loading of fallen top coal is accomplished with the loading machine operator remaining in a protected position.

Reeves, J. A. Continuous Mining of Pitching Coal Seams. Min. Cong. J., January 1966, pp. 27-30.

The mine conditions and mining method at the Dutch Creek mine in Colorado are described. Mining sequence, pillar recovery, and ventilation are discussed.

Salamon, M. D. G., and J. I. Oravecz. Rock Mechanics in Coal Mining. The Chamber of Mines of South Africa, Johannesburg, South Africa, 1976.

This document describes pillar extraction methods used in South Africa and includes a discussion on support in bord and pillar workings and haulages. Rock mechanics is the main theme of the material, and discussions in this area include considerations in multi-seam mining and improving the stability of pillared areas.

Saperstein, L. W., G. R. Brown, J. D. Bennett, R. Murphy, F. Gilliam, and R. B. Anderson. New Miner Orientation Manual: An Instruction Training Manual. Pennsylvania State University, University Park, Pa., September 1976.

This instruction training manual includes such topics as coal geology, ventilation, roof and rib control, haulage, and accident prevention.

Schlick, D. P., and R. W. Dalzell. Ventilation of Continuous-Miner Places in Coal Mines. BuMines IC 8161, 1963, 18 pp.

This article presents a representative cross section of methods successfully used to ventilate continuous-miner places as well as various factors that should be considered when selecting auxilliary ventilating equipment.

Schroder, J. L., Jr. Continuous Miners Extract High Splint Pillars. Coal Age, December 1966, pp. 84-87.

This article describes the pocket-and-wing pillar extraction method used to mine the High Split seam in Kentucky. The plans had to take into

account an extremely soft bottom and areas vulnerable to bumps. Advantages of the system are given, and major considerations during extraction are stressed.

Shields, J. J., and J. J. Dowd. Mechanical Mining in Some Bituminous Coal Mines. Progress Report 9. Face Haulage. BuMines IC 7978, 1960, 106 pp.

This study concerns different methods of face haulage used with various types of continuous mining machines, mobile loading machines, and track-mounted equipment under varying roof and bottom conditions and in coalbeds of varying thicknesses. Face haulage methods used in 13 mines in Pennsylvania, West Virginia, Ohio, and Illinois are studied and compared.

Shields, J. J., J. J. Dowd, and W. A. Haley. Mechanical Mining in Some Bituminous Coal Mines. Progress Report 8. Methods and Equipment Used in Underground Development. BuMines IC 7813, 1957, 66 pp.

Methods and equipment used in underground bituminous coal mine development in 14 mines were studied to determine how the application of modern methods and equipment affect the rate of entry development. The study revealed a tendency toward equalization of the output per man between development and production.

Shields, J. J., M. O. Magnuson, W. A. Haley, and J. J. Dowd. Mechanical Mining in Some Bituminous Coal Mines. Progress Report 7. Methods of Mining With Continuous Mining Machines. BuMines IC 7696, 1954, 118 pp.

A description of mines and the mining and pillar extraction methods used by each with continuous mining methods is provided.

Snarr, F. E. A Complete Continuous Mining System. Min. Cong. J., July 1955, pp. 20-23.

Illinois coal seam pillars are extracted by the Marietta miner (a modified continuous miner). Problems encountered and solutions are discussed.

Stahl, R. W. Extracting Final Stump in Pillars and Pillar Lifts With Continuous Miners. BuMines RI 5631, [1960], 13 p.

This article discusses various pillar extraction methods used in Pennsylvania with continuous mining machines. Common practices are delineated and safe practices are suggested.

Stephenson, H. G., C. W. Gregory, and W. J. Riva. Pillar Extraction in Thick Coal at Canmore, Alberta, on Gradients Between 5 and 30 Degrees. CIM Bull., November 1972, pp. 52-62.

This article describes the methods used for pillar extraction in the Wilson seam at Canmore Mines, Alberta. Initially, a continuous miner/ shuttle car system was used. However, due to a thick, very gassy seam where roof conditions varied from good to appalling and a gradient ranging from 5 to 30 degrees, the initial system was abandoned and a slusher-loader system used instead, with excellent results.

Stephenson, R. W., and J. D. Rockaway. Pillar Support in Underground Coal Mines. Proc. 14th Ann. Eng. Geol. and Soils Eng. Symp. Boise, Idaho, 1976, pp. 175-189.

An analysis, based on a sample of 25 mines, of the strength and stability parameters of the strata underlying the coal in major coal basins of the United States was undertaken. Practices for the design of coal pillars in mines underlain by weak floors are recommended based on the analysis.

Tien, J. C. J. Pros & Cons of Underground Ventilation Systems. Coal Min. and Proc., June 1978, pp. 110-134.

The basic principles underlying the blowing and exhausting ventilation systems and their advantages and disadvantages are discussed. Recommendations for improving ventilation are provided.

Transactions of the Institution of Mining Engineers (London). Transference of Roof Load, v. 108, 1949, pp. 490-504.

The reduction of roof loads in narrow workings at depth by a yielding pillar technique is described. The application of the yielding pillar technique to room-and-pillar extraction is also discussed, and conclusions are drawn.

Turnbull, L. A., and A. L. Toenges. Mechanical Mining in Some Bituminous Coal Mines. Progress Report 5. Extraction of Pillars With Mechanized Equipment. BuMines IC 7527, 1949, 59 pp.

This document is concerned primarily with the extraction of pillars and the mining problems incident to this phase of coal mining. The mining operations at several mines are described, which includes a general description of the mine and the mining method and pillar extraction procedure utilized.

U.S. Bureau of Mines. Ground Control Aspects of Coal Mine Design: Proceedings Bureau of Mines Technology, BuMines IC 8630, 1974, 138 pp.

This report includes an overview of the USBM approach to mine design and papers on problems associated with the design of panels and roof control.

U.S. Code of Federal Regulations. Title 30--Mineral Resources; Chapter 1--Mining Enforcement and Safety Administration. Federal Register, July 1977, pp. 3-559.

Regulations covering all aspects of mineral resources that are subject to enforcement by the Mining Enforcement and Safety Administration are presented.

U.S. Mining Enforcement and Safety Administration. Roof and Rib Control: Programmed Instruction Workbook No. 3, NMHSA-CE-003, 1976.

This publication is a programmed instruction workbook explaining roof and rib control. It includes a discussion on inspection and testing and accident prevention.

University of Utah. Site Characterization: 17th U.S. Symposium on Rock Mechanics Held at Snowbird, Utah, August 25-27, 1976. Utah Engineering Experiment Station, University of Utah, Salt Lake City, 1976.

Pertinent papers cover subjects including selection of model and method of analyses for application of rock mechanics to engineering problems; design consideration for mining thick seams and seams lying in close proximity to one another; general principles of underground opening design in competent rock; and rock mechanics elements for coal mine design.

Valeri, M. Pittsburgh-Seam Pillaring With Continuous Miners. Coal Age, March 1957, pp. 58-60.

This article describes the retreat mining system used at Nemacolin, Pennsylvania. Mine conditions, roof control, and ventilation are among the topics covered. The system involves the use of conventional units and continuous miners and an open-end pillaring method.

The Mining Engineer. Ventilation Planning as a Prerequisite for Winning Higher Outputs. September 1971, pp. 796-811.

Ventilation planning is discussed, including the economic consequences of inadequate ventilation capacity. Gas and dust control, underground booster fans, and firedamp drainage techniques are among the topics covered.

Vorobjev, B. M., and R. T. Deshmukh. Room-and-Pillar System. Advanced Coal Mining. Asia Publishing House, New York, v. 1, 1966.

A description of room and pillar and block mining is provided, including the different types of rooms and necks and the different advancing/retreating orders.

Wilson, J. W., B. D. Singh, and S. Nakajima. Design Consideration for Mining Thick Seams and Seams Lying in Close Proximity to One Another. Unpublished paper. Available from the Consolidation Coal Company, Pittsburgh, Pennsylvania.

This article inlcudes general principles of underground opening design in competent rock and a classification of rock.

Younkins, J. A. Pillar Extraction With Continuous Machines. Min. Cong. J., April 1952, pp. 36-39.

The pillar extraction method employed with continuous machines at a Pennsylvania mine is described.

Zachar, Frank R., Factors Influencing the Selection of Mining Systems. Min. Cong. J., October 1969, pp. 32-40.

This article discusses the factors that need to be considered in selecting a mining system (i.e., seam thickness, roof control and depth of cover, seam characteristics, market requirements, labor and supervision availability, return on capital investment, equipment, and ventilation requirements). Two different mining methods used in mining Pittsburgh seam coal are then compared.

APPENDIX. - RETREAT MINING PRACTICES

This appendix contains tables summarizing the retreat mining practices in all but one of the MSHA districts. (District 1 is not included because it contains only anthracite coal mines.) This appendix parallels the discussions in chapter 3 of this publication.

A series of tables containing information summarized from the MSHA roof control plans are arranged in descending order of classification, by MSHA district, State (if necessary), seam, and county. For example, in MSHA District 2, the first table is for the Brookville coal seam and entries are provided for each of the counties in which mining is conducted. The Upper Freeport Seam is listed first in the district because it has the greatest number of mines (31). The next table contains data from the Pittsburgh Seam, which contains 30 mines. In this manner, the tables are arranged from seams with the most mines to those with the least mines. The counties are ordered depending upon the number of mines in the county.

Within the tables, the information is arranged as follows:

Column 1: County. The county in which the mines are located.

Column 2: No. RCP. The number of roof control plans (RCP's) analyzed from the county noted in column 1.

Column 3: Most Popular Process. Pillar extraction process most frequently practiced in the county. The following abbreviations are used:

S&F - split and fender.

P&W - pocket and wing.

O.E. - open end.

O.L. - outside lifts.

P.O. - partial extraction using outside lifts.

P.S. - partial extraction using splitting.

No - more mines in the county do not practice pillar extraction than practice any of the individual pillar extraction processes.

I.D. - insufficient data for categorizing any process as the most popular.

Column 4: S&F. Number of mines in the county that have a plan on file for full pillar extraction by the split-and-fender process.

Note: Roof control plans frequently contain pillar extraction plans for more than one process. It is entirely possible that a single roof control plan could contain plans for full pillar

extraction using each of the four basic processes and partial pillar extraction by both outside lifts and splitting. The result is that the entries in a row rarely add up to the total number of roof control plans analyzed in that county.

Column 5: P&W. Number of mines in the county that have a plan on file for full pillar extraction using the pocket-and-wing process.

Column 6: O.E. Number of mines in the county that have a plan on file for full pillar extraction using the open-end process.

Column 7: O.L. Number of mines in the county that have a plan on file for full pillar extraction using the outside-lifts process.

Column 8: Other. Number of mines in the county that have a plan on file for full pillar extraction using a process that does not fit into one of the four basic pillar extraction process classification categories. An entry in this column should be coupled with an explanatory entry in the "Other information" column.

Column 9: O.L. Number of mines in the county that have a plan file for partial pillar extraction by removing outside-lifts.

Column 10: Split. Number of mines in the county that have a plan on file for partial pillar extraction by taking splits through pillars.

Column 11: Other. Number of mines in the county that have a plan on file for partial pillar extraction using a method that is not classifiable as outside lifts or splitting. An entry in this column should be coupled with an entry in the "Other information" column.

Column 12: Do Not Pillar. Number of mines in the county that do not have plans for pillar extraction on file.

Column 13: Other Information. Used for providing further elaboration when necessary.

The purpose of presenting the tables that comprise the remainder of the appendix is to aid mine management in the selection of the retreat mining practice that will have the best chance of success in their mine. Careful consideration of the information in these tables is essential for any mine manager who is considering retreat mining.

DISTRICT 2

SEAM Upper Freeport OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Indiana	10	S&F	8	5		2		1	2		3	
Allegheny	6	I.D.	3	3							2	
Armstrong	6	I.D.	2			2		1	1		3	
Somerset	5	S&F	3			1					3	
West-moreland	3	No									3	
Cambria	1	I.D.	1	1					1			
TOTAL	31											

SEAM Pittsburgh OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Washington	13	P&W	10	15				10	3		1	
Greene	10	P&W	5	11				4	1		2	
Allegheny	2	P&W	1	2				1				
Fayette	2	P&W	1	2				1				
West-moreland	2	S&F	2	1				1				
Indiana	1	No									1	
TOTAL	30											

SEAM Lower Kittanning OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Cabria	7	S&F	7	1	1				3			
Indiana	7	No	3								4	
Somerset	6	S&F	3	1							2	
Armstrong	3	No							1		2	
Jefferson	1	No									1	
Clearfield	1	P.S.							1			
TOTAL	25											

DISTRICT 2

SEAM Lower Freeport OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Indiana	6	S&F	3	1		1			2		2	
Cambria	3	I.D.	3	3					2			
Jefferson	4	No							1		3	
Armstrong	1	I.D.	1			1						
TOTAL	14											

SEAM Upper Kittanning OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Somerset	7	S&F	5	1		1		2	4			
Cambria	4	S&F	3						2			
TOTAL	11											

SEAM Sewickley OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Greene	6	I.D.	3	3							2	
TOTAL	6											

SEAM Clarion OTHER NAMES Fulton

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Indiana	1	S&F	1									
Huntingdon	1	No									1	
TOTAL	2											

DISTRICT 2

SEAM Middle Kittanning OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Clearfield	1	No									1	
Canbria	1	No									1	
TOTAL	2											

SEAM Brookville OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Centre	1	S&F	1									
TOTAL	1											

DISTRICT 3

SEAM Pittsburgh OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Harrison	10	No		2		1			3		4	
Marshall	7	P.S.							6		1	
Monongalia	7	P&W		4					3			
Marion	6	P&W	1	6								
Barbour	3	No							1		2	
Brooke	3	No				1					2	
Gilmer	3	S&F P.S. No	1						1		1	
TOTAL	38											

SEAM Upper Freeport OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Preston	17	P.S.						1	11		5	
Garrett, Maryland	3	No									3	
Grant	2	O.L.				2						
Barbour	1	No									1	
Monongalia	1	No									1	
Upshur	1	O.L.				1						
TOTAL	25											

SEAM Sewell OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Randolph	17	no	1	2			*1		6		9	*Diagonal Cuts
TOTAL	17											

DISTRICT 3

SEAM Redstone OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Monongalia	6	S&F	3						2		1	
Barbour	5	S&F	3						1		1	
Lewis	2	O.L. No				1					1	
Upshur	1	S&F	1									
TOTAL	14											

SEAM Sewickley OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Monongalia	13	S&F	7	2				1			3	
Marion	1	No									1	
TOTAL	14											

SEAM Middle Kittanning OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Upshur	5	No	2								3	
Braxton	1	No									1	
Garrett, Maryland	1	P.O.						1				
TOTAL	7											

SEAM Peerless OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Randolph	5	No									5	
TOTAL	5											

DISTRICT 3

SEAM Lower Kittanning OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Barbour	2	No									2	
Marion	1	P.O.						1				
TOTAL	3											

SEAM Bakerstown OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Grant	2	S&F	2									
TOTAL	2											

SEAM Gilbert OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Randolph	2	O.L. No						1			1	
TOTAL												

SEAM Barton OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Garrett, MD	1	No									1	
TOTAL	1											

SEAM Clarion OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Braxton	1	No									1	
TOTAL	1											

DISTRICT 3

SEAM Hughs Ferry OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Randolph	1	No									1	
TOTAL	1											

SEAM Upper Kittanning OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Barbour	1	No									1	
TOTAL	1											

SEAM Welch OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Randolph	1	No									1	
TOTAL	1											

DISTRICT 4

SEAM Sewell OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Wyoming	34	No	5								29	
McDowell	30	S&F No	15	3					3		15	
Nicholas	27	No	5			2					22	
Webster	17	No	1						2		14	
Fayette	12	No	2								10	
Greenbriar	6	S&F	3						1		2	
Raleigh	2	S&F No	1						1		1	
TOTAL	128											

SEAM Eagle OTHER NAMES # 1 Gas, Mohawk, Bens Creek

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Logan	23	No	3					2	3		16	
Nicholas	23	No	3						1		21	
Wyoming	17	No	3			1			1		13	
Fayette	9	No	2		1	1			2		7	
McDowell	6	No	1						1		4	
Kanawha	3	S&F	2						1			
Mingo	3	No							1		2	
Boone	1	I.D.	1	1		1						
Webster	1	P.S.									1	
TOTAL	86											

DISTRICT 4

SEAM #2 Gas   OTHER NAMES Campbell Creek, Pond Creek, Upper War Eagle, Logan Eagle

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Mingo	31	No	6						9		17	
Raleigh	13	No	5		1	1			2		8	
Boone	10	S&F	5	2		1			3		3	
Kanawha	7	S&F	5						1		2	
Logan	7	No	1						2		5	
Wyoming	6	P.S. No	1			1			3		3	
Fayette	5	S&F	3						1		2	
McDowell	4	No									4	
TOTAL	83											

SEAM #5 Block   OTHER NAMES Lower Kittanning

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Kanawha	16	P.S.	7						9		5	
Nicholas	16	No	2						1		13	
Boone	12	No							3		9	
Fayette	9	No	1						1		8	
Logan	9	S&F P.S. No	3						3		3	
Clay	6	No							2		4	
Raleigh	1	I.D.	1						1			
TOTAL	69											

SEAM Pocahontas #3   OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
McDowell	23	S&F	18	10	-	4			1		2	
Raleigh	22	No	6	-	1	2			2		16	
Mercer	12	No	3	2	-	2					9	
Wyoming	11	S&F	9	6	1	2					2	
Fayette	1	No									1	
TOTAL	69											

DISTRICT 4

SEAM Cedar Grove OTHER NAMES Thacker

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Logan	33	No	8			1		3	10		15	
Mingo	14	No	1			1					13	
Boone	11	No	3	2					3		7	
Wyoming	7	P.S.							5		2	
TOTAL	65											

SEAM Red Ash OTHER NAMES Douglass, Raven Red Ash

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
McDowell	46	No	4						4		38	
Wyoming	8	No									8	
TOTAL	54											

SEAM Winifrede OTHER NAMES Dorothy

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Boone	18	No	3	2					3		13	
Logan	18	No	1					1	1		16	
Kanawha	8	No	1					1	2		6	
Mingo	3	No							1		2	
Wyoming	2	P.S. No	1						1		1	
Fayette	1	I.D.	1		1				1			
Nicholas	1	No									1	
Raleigh	1	S&F	1									
Wayne	1	No									1	
TOTAL	53											

DISTRICT 4

SEAM Beckley OTHER NAMES Pocahontas #12, War Creek

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Raleigh	22	No	4	1					1		18	
Wyoming	11	No	3						3		7	
McDowell	8	S&F	6						1		1	
Greenbriar	2	No									2	
Mercer	1	S&F	1									
Nicholas	1	No									1	
TOTAL	45											

SEAM Pocahontas #11 OTHER NAMES Firecreek

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
McDowell	21	No	6	-	1	2			4		13	
Fayette	8	No	1								7	
Raleigh	8	No									8	
Greenbriar	2	No									2	
Mercer	1	O.E.			1				1			
TOTAL	41											

SEAM Stockton-Lewiston OTHER NAMES Lewiston-Belmont

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Boone	16	No	2						7		8	
Logan	8	No							3		5	
Kanawha	8	No							1		7	
Fayette	3	No							1		2	
McDowell	1	No									1	
Raleigh	1	No							1			
TOTAL	37											

DISTRICT 4

SEAM Pocahontas #6 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.E.	Split	Other	Do Not Pillar	Other Information
Wyoming	16	No	4	1					2		11	
Greenbriar	7	No	1						1		5	
McDowell	5	S&F	3	2							1	
Summers	4	No									4	
Mercer	1	I.D.							1			
Raleigh	1	No									1	
TOTAL	34											

SEAM Gilbert OTHER NAMES McGowan

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Wyoming	24	No	10								14	
McDowell	4	No	1								3	
Nicholas	2	No									2	
Fayette	1	No									1	
TOTAL	31											

SEAM Alma OTHER NAMES Warfield

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Mingo	25	No	3	1		1			4		17	
Logan	4	No									4	
McDowell	1	No									1	
TOTAL	30											

DISTRICT 4

SEAM Coalburg OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.E.	O.L.	Other		
Kanawha	11	No	2		1				2		8	
Logan	7	No							2		5	
Mingo	7	No									7	
Boone	3	No									3	
Clay	1	No									1	
TOTAL	29											

SEAM Chilton OTHER NAMES Taylor

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Logan	29	No	5					1	5		19	
TOTAL	29											

SEAM Pocahontas #4 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
McDowell	15	S&F P&W	11	11	1	2			2		4	
Raleigh	8	No	1		1						7	
Wyoming	6	No	2						1		3	
TOTAL	29											

SEAM Lower Cedar Grove OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Logan	14	No						1	2		11	
Mingo	11	No	4	2				1	2		5	
Boone	1	No									1	
Wyoming	1	P.S.							1			
TOTAL	27											

DISTRICT 4

SEAM Peerless OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Nicholas	8	No							1		7	
Webster	6	No	1								5	
Boone	5	No	1						1		4	
Kanawha	3	No									3	
Raleigh	2	S&F No	1								1	
TOTAL	24											

SEAM Powellton OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Logan	5	P.S.							3		2	
Boone	3	I.D.	1	1							2	
Fayette	3	No						1			2	
Kanawha	3	No	1						1		2	
Wyoming	2	S&F P.S.	1						1			
Raleigh	1	P.S.							1			
TOTAL	17											

DISTRICT 4

SEAM Little Eagle OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Wyoming	6	No	1						1		4	
Fayette	3	No									3	
McDowell	1	No									1	
Nicholas	1	No									1	
TOTAL	11											

SEAM Pocahontas #10 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
McDowell	10	S&F	6								4	
TOTAL	10											

SEAM Welch OTHER NAMES Smith

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
McDowell	10	No	3								7	
TOTAL	10											

SEAM Pocahontas #5 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
McDowell	6	S&F No	3	2							3	
Raleigh	3	No									3	
TOTAL	9											

DISTRICT 4

SEAM Pocahontas #9 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
McDowell	9	S&F	5						1		4	
TOTAL	9											

SEAM Hernshaw OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Boone	4	S&F O.L.	2			2			1		1	
Kanawha	2	S&F	1						1		1	
Raleigh	1	S&F	1						1			
TOTAL	7											

SEAM Lower War Eagle OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
McDowell	4	No							1		3	
Mingo	1	I.D.	1					1	1			
Wyoming	1	No									1	
TOTAL	6											

SEAM Upper Eagle OTHER NAMES Matewan

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Raleigh	4	S&F	4						1			
Logan	1	No									1	
Wyoming	1	No									1	
TOTAL	6											

DISTRICT 4

SEAM Upper Kittanning OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Nicholas	5	No									5	
Clay	1	No									1	
TOTAL	6											

SEAM Bradshaw OTHER NAMES Hughes Ferry, Iaeger

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
McDowell	4	S&F	3								1	
TOTAL	4											

SEAM Lower Freeport OTHER NAMES Freeport

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Boone	3	S&F	2								1	
Mingo	1	No									1	
TOTAL	4											

SEAM Williamson OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Logan	2	S&F No	1								1	
Mingo	1	No									1	
TOTAL	3											

DISTRICT 4

SEAM Pocahontas #2 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
McDowell	1	No									1	
Mercer	1	No									1	
TOTAL	2											

SEAM Pittsburgh 8 OTHER NAMES Raymond

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Mason	1	No									1	
TOTAL	1											

SEAM Glen Alum OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Fayette	1										1	
TOTAL	1											

DISTRICT 5

SEAM Blair OTHER NAMES Eagle, Bens Creek, Norton #1

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Buchanan	184	No	5					3	19		157	
Dickenson	4	No							1		3	
Wise	2	No									2	
TOTAL	190											

SEAM Widow Kennedy OTHER NAMES Kennedy

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Buchanan	92	No	9					3	8		63	
Russell	27	No	1						4		22	
Dickenson	13	No									13	
Scott	1	No									1	
TOTAL	133											

SEAM Splashdam OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Buchanan	95	No	1		1			3	5		85	
Dickenson	17	No							2		15	
Wise	1	No									1	
TOTAL	113											

SEAM Banner OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Dickenson	45	No	8					1	6		31	
Wise	18	No	2					1	2		13	
Buchanan	11	No	2						1		9	
Russel	9	No									9	
TOTAL	83											

DISTRICT 5

SEAM Jawbone OTHER NAMES Tiller

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Buchanan	65	No	8					1	10		46	
Wise	6	No									6	
Dickenson	4	No									4	
Tazewell	4	No	1								3	
Russell	3	S&F	2						1		1	
TOTAL	82											

SEAM Red Ash OTHER NAMES Imboden, Raven

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Buchanan	53	No	3		2			2	3		44	
Dickenson	12	No	1								11	
Russell	6	No							1		5	
Tazewell	4	No	1						1		3	
Wise	4	S&F	3	1								
TOTAL	79											

SEAM Hagy OTHER NAMES Norton

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Buchanan	64	No	4			1		1	13		48	
Wise	11	No									11	
Lee	2	No									2	
TOTAL	77											

SEAM Glamorgan OTHER NAMES Dorchester, Cedar

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Buchanan	39	No	1					3	10		27	
Dickenson	9	No									9	
Wise	9	No	1								8	
TOTAL	57											

DISTRICT 5

SEAM Mason OTHER NAMES Taggart

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Lee	30	No	1					1	1		29	
Wise	19	S&F	9					1	2	1	8	
TOTAL	49											

SEAM Clintwood OTHER NAMES Feds Creek, Matewan

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Buchanan	15	No	1					1	5		9	
Dickenson	12	No									12	
Wise	12	No									12	
TOTAL	39											

SEAM Horsepen OTHER NAMES Seaboard

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Tazewell	19	No	3						2		14	
TOTAL	19											

SEAM Bolling OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Wise	12	No	3		1				1		8	
TOTAL	12											

SEAM Parsons OTHER NAMES Morris, Smith

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Wise	11	No	2			2		1	1		7	
TOTAL	11											

DISTRICT 5

SEAM Pocahontas OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Buchanan	5	No	1	1					1		4	
Tazewell	5	No	1						1		3	
TOTAL	10											

SEAM Kelly OTHER NAMES Alma, Upper Elkhorn, Warfield

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Wise	5	No	1			1					4	
TOTAL	5											

SEAM Cove Creek OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Scott	3	No									3	
TOTAL	3											

SEAM Phillips OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Tazewell	1	No									1	
Wise	1	No									1	
TOTAL	2											

SEAM Lyons OTHER NAMES Fraley

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Wise	1	P.S.							1			
TOTAL	1											

DISTRICT 6

SEAM Elkhorn #3 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	58	No						1	5		52	
Letcher	53	No	7						5		43	
Floyd	46	No	1						9		36	
Johnson	9	No							1		8	
TOTAL	166											

SEAM Elkhorn #2 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	105	No	3						16		86	
Floyd	32	No							5		27	
Letcher	5	No	1								4	
TOTAL	142											

SEAM Hazard #4 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Letcher	68	No	2						6		60	
Floyd	25	No							4		21	
Pike	16	No	2						4		10	
Martin	14	No	1						6		7	
Magoffin	2	No									2	
Johnson	1	No									1	
TOTAL	126											

DISTRICT 6

SEAM Lower Elkhorn OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	113	No	10	1					25		80	
Letcher	5	No									5	
Martin	2	No									2	
TOTAL	120											

SEAM Elkhorn #1 OTHER NAMES Alma

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	80	No	5						9		66	
Floyd	13	No									13	
Martin	1	P.S.							1			
TOTAL	94											

SEAM Winifrede OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	33	No							8		25	
Magoffin	14	No									14	
Floyd	7	No							2		5	
Letcher	6	No							2		4	
Martin	2	No									2	
Johnson	1	No									1	
TOTAL	62											

DISTRICT 6

SEAM Broas OTHER NAMES Peach Orchard, Hatcher

County	No. RCP	Most Popular Process	Full Extraction: S&F	Full Extraction: P&W	Full Extraction: O.E.	Full Extraction: O.L.	Full Extraction: Other	Partial Extraction: O.L.	Partial Extraction: Split	Partial Extraction: Other	Do Not Pillar	Other Information
Pike	26	No	2						6		18	
Floyd	16	P.S.						2	8		6	
Martin	6	I.D.	3						3		3	
Johnson	5	No									5	
Magoffin	2	No									2	
TOTAL	55											

SEAM Clintwood OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction: S&F	Full Extraction: P&W	Full Extraction: O.E.	Full Extraction: O.L.	Full Extraction: Other	Partial Extraction: O.L.	Partial Extraction: Split	Partial Extraction: Other	Do Not Pillar	Other Information
Pike	46		4						15		28	
TOTAL	46											

SEAM Amburgy OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction: S&F	Full Extraction: P&W	Full Extraction: O.E.	Full Extraction: O.L.	Full Extraction: Other	Partial Extraction: O.L.	Partial Extraction: Split	Partial Extraction: Other	Do Not Pillar	Other Information
Floyd	8	No									8	
Pike	7	No							1		6	
Letcher	2	No									2	
TOTAL	17											

SEAM Whitesburg OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction: S&F	Full Extraction: P&W	Full Extraction: O.E.	Full Extraction: O.L.	Full Extraction: Other	Partial Extraction: O.L.	Partial Extraction: Split	Partial Extraction: Other	Do Not Pillar	Other Information
Letcher	14	No									14	
Pike	2	No									2	
Floyd	1	No									1	
TOTAL	17											

DISTRICT 6

SEAM Eagle OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	15	No							2		13	
TOTAL	15											

SEAM Splashdam OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	11										11	
TOTAL	11											

SEAM Hagy OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pike	10	No									10	
TOTAL	10											

SEAM Hazard #6 and #7 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Magoffin	1	No									1	
Pike	2	No									2	
TOTAL	3											

SEAM Skyline OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Magoffin	2	No									2	
TOTAL	2											

DISTRICT 6

SEAM No. 5 Block OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Martin	2	P.S.							2			
TOTAL	2											

DISTRICT 7—Alabama

SEAM Blue Creek OTHER NAMES Richland, Upper Cliff

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Jefferson	3	No	1		1			1			2	
Tuscaloosa	3	No									3	
Cherokee	1	No									1	
TOTAL	7											

SEAM Mary Lee OTHER NAMES Sewanee, Sewell

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Jefferson	4	No						1			3	
Walker	3	I.D.	1				1		1		2	
TOTAL	7											

SEAM Black Creek OTHER NAMES Wilder, Battle Creek

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Marion	2	No									2	
Blount	1	No									1	
Jackson	1	No									1	
Jefferson	1	No									1	
TOTAL	5											

SEAM Pratt OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Jefferson	3	O.E. Other			2		1					
Fayette	1	S&F	1									
TOTAL	4											

DISTRICT 7—Alabama

SEAM America OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Walker	2	No See Note					*1					*Diagonal cuts through pillar
Jefferson	1	See Note					*1					*Diagonal cuts through pillar
TOTAL	3											

SEAM Gholson OTHER NAMES Mammoth

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Shelby	2										2	
TOTAL	2											

DISTRICT 7—Kentucky

SEAM Hazard #4 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Leslie	60	No	2		2				3	2	54	
Knott	33	No	6						3		25	
Perry	12	No	2						2		10	
Bell	7	No		1					1	1	5	
Harlan	7	No						1	3		4	
Clay	6	No									6	
Knox	3	No									3	
Breathitt	1	No									1	
TOTAL	129											

SEAM Elkhorn #3 OTHER NAMES Darby, Kellika, Stearns #3, Lower Mason, Rim

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Harlan	68	No	1	1	1				3		62	
Knott	39	No	1							1	37	
Knox	1	No									1	
McCreary	1	No									1	
Perry	1	No									1	
TOTAL	110											

SEAM Elkhorn #1 OTHER NAMES Hance, Blue Gem, Jellico Harlan, Lower Elkhorn

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Harlan	59	No		1	1			3	7	7	46	
Knox	22	No									22	
Knott	9	No	1								8	
Bell	7	No	1			1					6	
Whitley	4	No									4	
McCreary	1	I.D.	1					1	1			
TOTAL	102											

DISTRICT 7—Kentucky

SEAM Upper Mason OTHER NAMES Creech, Mason, Amburgy, D

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Harlan	62	No						5	11	9	47	
Bell	12	No							2	2	10	
TOTAL	74											

SEAM Hazard No. 5 & 5A OTHER NAMES Haddix, Smith, Hignite

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Leslie	14	No	1						1		12	
Perry	14	No	1						2		12	
Bell	11	No		2				1	2		8	
Harlan	10	No						3	3		7	
Breathitt	3	No									3	
Knott	2	No									2	
Clay	1	No									1	
TOTAL	55											

SEAM Hazard No. 6 & 7 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Knott	22	No	1						1		20	
Perry	18	No	2						4		13	
Breathitt	3	No									3	
Harlan	3	No	1	1					1		2	
TOTAL	46											

DISTRICT 7—Kentucky

SEAM Horse Creek OTHER NAMES Glen Mary, Lily

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Clay	21	No									21	
Laurel	4	No									4	
Leslie	1	No									1	
Pulaski	1	No									1	
Rockcastle	1	No									1	
TOTAL	28											

SEAM Elkhorn #2 OTHER NAMES Leonard, Stearns #2

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Bell	6	No									6	
Knott	6	No									6	
Wayne	2	No									2	
Jackson	1	No									1	
McGreary	1	P.S.							1			
Pulaski	1	I.D.						1	1			
TOTAL	17											

SEAM Hazard #9 OTHER NAMES Hindman

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Harlan	4	No									4	
Perry	4	S&F No	2						1		2	
Knott	2	No									2	
Leslie	2	I.D.						1	1		1	
TOTAL	12											

DISTRICT 7—Kentucky

SEAM Hazard #8 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Leslie	2	No									2	
Harlan	1	No									1	
Perry	1	No									1	
TOTAL	4											

SEAM Whitesburg OTHER NAMES E

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Clay	1	P.S.							1			
Harlan	2	No									2	
TOTAL	3											

SEAM High Splint OTHER NAMES No. 5 Block, Lower Kittanning

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Breathitt	1	No									1	
Harlan	1	S&F	1									
TOTAL	2											

SEAM Skyline OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Breathitt	2	No									2	
TOTAL	2											

DISTRICT 7—Kentucky

SEAM Barren Fork OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Laurel	1	No									1	
TOTAL	1											

SEAM Hazard No. 4A OTHER NAMES Walnut Mountain

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Clay	1	See Note					1					Diagonal Splitting; Remote Control
TOTAL	1											

DISTRICT 7 - Tennessee

SEAM Dean OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Anderson	30	No	5						5	1	24	
Campbell	14	No									14	
Scott	3	No									3	
Morgan	1	I.D.	1						1			
TOTAL	48											

SEAM Jellico OTHER NAMES Harlan, Lower Elkhorn

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Campbell	22	No									22	
Claiborne	8	No	1	1						1	6	
Anderson	7	No									7	
Scott	5	No									5	
Morgan	1	No									1	
TOTAL	43											

SEAM Sewanee OTHER NAMES Lantana, Mary Lee, Sewell

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Marion	18	No	1		3				4		13	
Sequatchie	6	No									6	
Grundy	2	I.D.			1				1		1	
Hamilton	2	No									2	
Bledsoe	1	No									1	
TOTAL	29											

DISTRICT 7 - Tennessee

SEAM Walnut Mountain OTHER NAMES Red Ash

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Anderson	14	No	2						4		10	
Campbell	5	No									5	
Marion	2	No									2	
Scott	2	No									2	
Morgan	1	No									1	
TOTAL	24											

SEAM Rich Mountain OTHER NAMES Blue Gem

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Campbell	16	No									16	
Anderson	1	No									1	
Claiborne	1	No									1	
TOTAL	18											

SEAM Glen Mary OTHER NAMES Poplar, Poplar Creek, Horse Creek

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Scott	6	No									6	
Anderson	2	No									2	
TOTAL	8											

SEAM Joyner OTHER NAMES Elkhorn #1, Alma

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Anderson	7	No									7	
Campbell	1	No									1	
TOTAL	8											

DISTRICT 7 - Tennessee

SEAM Rex OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Claiborne	4	No									4	
Campbell	3	No									3	
TOTAL	7											

SEAM Piedmont OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Anderson	6	No									6	
TOTAL	6											

SEAM Coal Creek OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Anderson	3	No									3	
Campbell	1	No									1	
Morgan	1	No									1	
TOTAL	5											

SEAM PeeWee OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Campbell	2	No									2	
Anderson	1	P.S.							1			
Morgan	1	No									1	
TOTAL	4											

SEAM High Splint OTHER NAMES Red Spring, Lower Kittanning

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Campbell	3	No									3	
TOTAL	3											

DISTRICT 7 - Tennessee

SEAM Nelson OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Morgan	2	No									2	
Rhea	1	No									1	
TOTAL	3											

SEAM Richland OTHER NAMES Blue Creek

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Rhea	2	No									2	
Hamilton	1	No									1	
TOTAL	3											

SEAM Wilder OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Fentress	1	No									1	
Overton	1	P.S.							1			
Putman	1	No									1	
TOTAL	3											

SEAM Block OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Anderson	2	No									2	
TOTAL	2											

SEAM Murray OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Campbell	2	No									2	
TOTAL	2											

DISTRICT 7 - Tennessee

SEAM Peabody OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Campbell	2	No									2	
TOTAL	2											

SEAM Brimstone OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Scott	1	No									1	
TOTAL	1											

SEAM Jordon OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Campbell	1	No									1	
TOTAL	1											

DISTRICT 8 - Illinois and Indiana

SEAM Illinois #6 OTHER NAMES Grade Creek #5, Herrin

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Franklin	5	S&F	4								*1	*Longwall
Jefferson	3	S&F	3					1				
Randolph	3	No						1			2	
Douglas	2	No									2	
Macoupin	2	No									2	
Williamson	2	S&F No	1								1	
Christian	1	No									1	
Clinton	1	No									1	
Montgomery	1	P.O.						1				
St. Clair	1	P.O.						1				
Vermillian	1	No									1	
TOTAL	22											

SEAM Illinois #5 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Saline	2	P.O.						2				
Williamson	2	No									2	
Wabash	1	P.O.						1				
TOTAL	5											

SEAM Indiana #5 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Greene	1	No									1	
Pike	1	No									1	
Warrick	1	No									1	
TOTAL	3											

DISTRICT 8

SEAM Indiana #6 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Knox, Co.	1	No									1	
TOTAL	1											

DISTRICT 8 - Ohio

SEAM Pittsburgh #8 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Belmont	6	P.O.						6				
Harrison	2	P.O.						2				
Monroe	2	P.O.						2				
TOTAL	10											

SEAM #C OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Perry	3	No									3	
Coshocton	2	No									2	
Muskingum	1	No									1	
TOTAL	6											

SEAM #4A OTHER NAMES Clarion

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Jackson	2	No									2	
Meigo	2	No									2	
Vinton	2	No									2	
TOTAL	6											

SEAM #6A OTHER NAMES Lower Freeport, Ohio Freeport

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Harrison	4	P.O.						2	1	1		
Tuscarawas	1	No									1	
TOTAL	5											

DISTRICT 8 - Ohio

SEAM #8A OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Meigo	1	No									1	
TOTAL	1											

SEAM 7 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Guernsey	1	No									1	
TOTAL	1											

DISTRICT 9 - Arkansas, Oklahoma

SEAM Hartshorne OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
LeFlore, Oklahoma	3	No									3	
Sebastion Arkansas	1	No									1	
TOTAL	4											

DISTRICT 9 - Iowa

SEAM Cherokee OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Monroe	2	No									2	
TOTAL	2											

DISTRICT 9 - Mew Mexico

SEAM York OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Colfax	2	S&F	2									
TOTAL	2											

DISTRICT 9 - Wyoming

SEAM Bed 50 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Carbon	1	No									1	
TOTAL	1											

DISTRICT 9 - Wyoming

SEAM Rock Springs # 3 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Sweetwater	1						1					Outside Lifts on Diamond-Diamond Pillars
TOTAL	1											

DISTRICT 9 - Colorado

SEAM B OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Pitkin	4	S&F No	2								2	
Gunnison	2	S&F No	1								1	
TOTAL	6											

SEAM E OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Delta	2	S&F No	1								1	
Gunnison	2	S&F	2									
Garfield	1	No									1	
TOTAL	5											

SEAM Cameo OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Mesa	3	No	1								2	
TOTAL	3											

SEAM C OTHER NAMES Juanita

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Gunnison	2	S&F No	1								1	
TOTAL	2											

DISTRICT 9 - Colorado

SEAM D OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Carfield	1	No									1	
Delta	1	S&F	1									
TOTAL	2											

SEAM F OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Gunnison	2	P.S. No							1		1	
TOTAL	2											

SEAM A OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Pitkin	1	No									1	
TOTAL	1											

SEAM Allen OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Los Animas	1	S&F	1									
TOTAL	1											

SEAM Anderson OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	P&W	O.E.	O.L.	Other	Partial Extraction O.L.	Split	Other	Do Not Pillar	Other Information
Pitkin	1	No									1	
TOTAL	1											

DISTRICT 9 - Colorado

SEAM Apache OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Las Animas	1	No									1	
TOTAL	1											

SEAM Brookside OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Fremont	1	No									1	
TOTAL	1											

SEAM Laramie #3 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Weld	1	I.D.	1						1			
TOTAL	1											

SEAM Lower Starkville OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Los Animas	1	No									1	
TOTAL	1											

SEAM Pinnacle OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Routt	1	I.D.	1						1			
TOTAL	1											

DISTRICT 9 - Colorado

SEAM Pueblo OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
LaPlata	1	No									1	
TOTAL	1											

SEAM Sunny Ridge OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Garfield	1	No									1	
TOTAL	1											

SEAM Wade OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Routt	1	No									1	
TOTAL	1											

SEAM Wattis OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Carbon	1	I.D.						1	1			
TOTAL	1											

DISTRICT 9 - Utah

SEAM Hiawatha OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Emery	3	P.S.	1						2		1	
Carbon	2	I.D.	1					1	1			
Sevier	1	P.S.							1			
TOTAL	6											

SEAM Blind Canyon OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Emery	4	S&F	3				2		2		1	
TOTAL	4											

SEAM Sunnyside OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Carbon	3	S&F	3									
Emery	1	I.D.	1						1			
TOTAL	4											

SEAM B OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction					Partial Extraction			Do Not Pillar	Other Information
			S&F	P&W	O.E.	O.L.	Other	O.L.	Split	Other		
Carbon	1	I.D.	1						1			
Grand	1	No									1	
Kane	1	I.D.	1						1		1	
TOTAL	3											

DISTRICT 9 - Utah

SEAM Rock Canyon OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Carbon	1	No									1	
TOTAL	1											

SEAM Subseam #3 OTHER NAMES

County	No. RCP	Most Popular Process	Full Extraction S&F	Full Extraction P&W	Full Extraction O.E.	Full Extraction O.L.	Full Extraction Other	Partial Extraction O.L.	Partial Extraction Split	Partial Extraction Other	Do Not Pillar	Other Information
Carbon	1	I.D.	1	1			*1					Bump Control Cuts
TOTAL	1											

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